Chemical Engineering

A McGRAW-HILL P...

AUGUST 25, 1958

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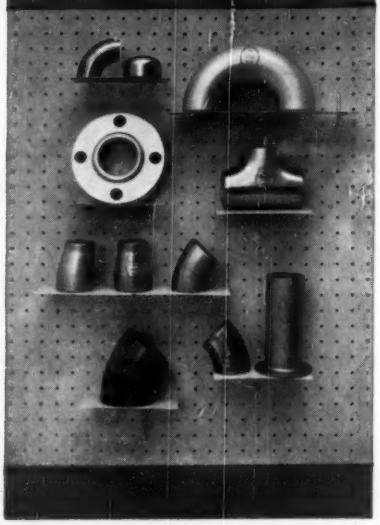

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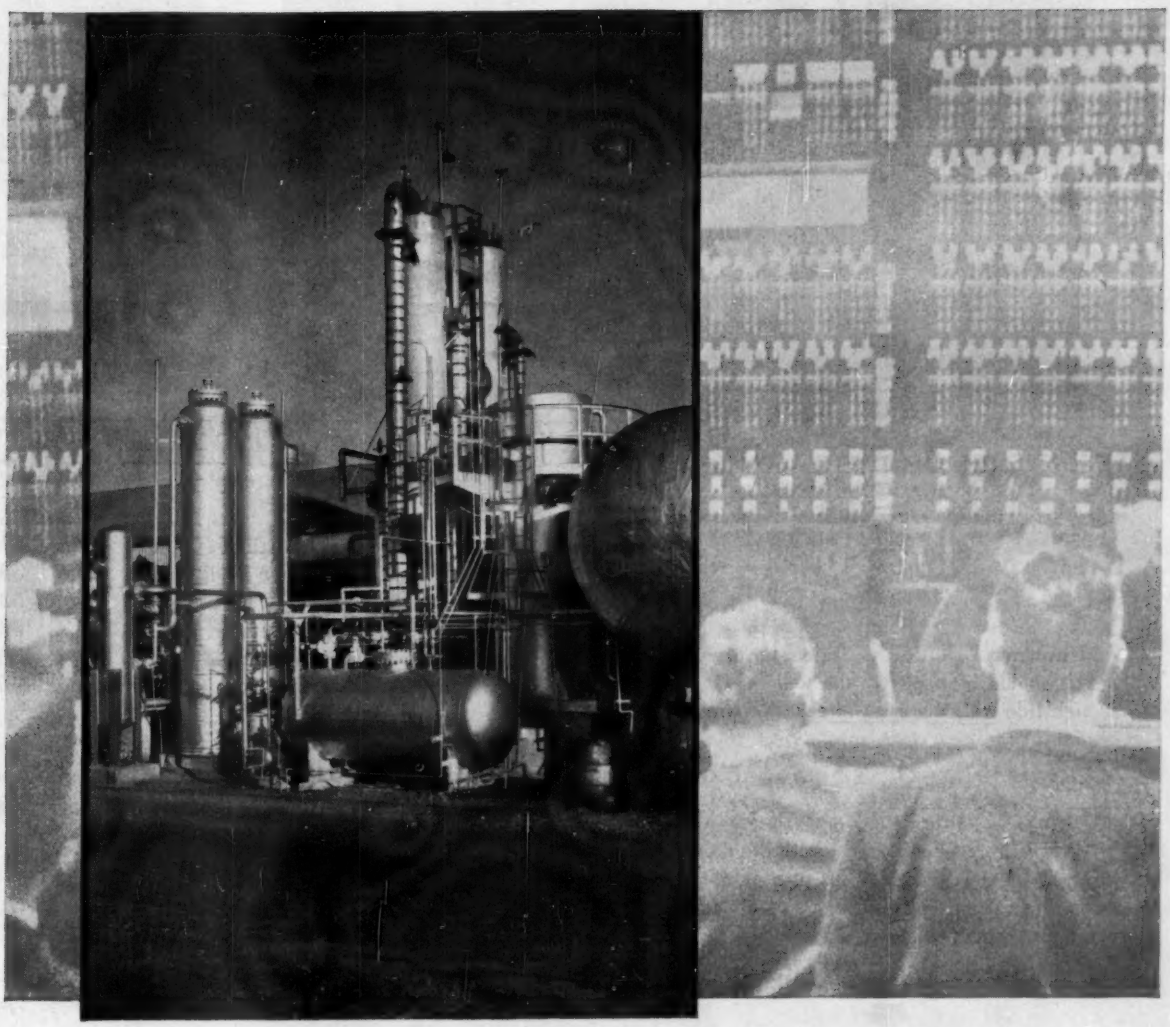

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17/26

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Fourth Clam: "A nationwide pool, that's what engineers have now. Within 48 hours an available engineer's qualifications and talents can be flashed to placement specialists all across the country. It's a new free service for engineers and employers." (p. 113)

Chemical

AUGUST 25, 1958

Developments in Chemical Engineering

CHEMENTATOR

Court Limits Engineer's Practice 51
Now: Shorter Route to Nuclear Fuel 53
Can Aussies Streamline TiO_2 Process 53
Uranium Colors Fertilizer Picture 53
Integration Better Than Segregation 56
New Plant Pours Forth Radioisotopes 56

PROCESSES & TECHNOLOGY

New Tall Oil Plant Reflects Refining Knowhow 58
Hydrogenator Converts Heavy Oil to Fuel Gas. 64

CHEMICAL ECONOMICS

Russia; Inflation; Atom Power; MAPI 70

CHEMICAL PRODUCTS

9 Newsworthy Chemicals and Raw Materials ... 74

PROCESS EQUIPMENT

21 Newsworthy Developments 78

Practice of Chemical Engineering

PROCESS FLOWSHEET

SX Line Wins Uranium From Variety of Ores .. 104

FEATURE ARTICLES

Costs Favor Hot Carbonate Process 113
A. G. Eickmeyer
New Waste Disposal Process 117
E. J. Zimmermann
Best Methods for Prandtl Number 121
W. R. Gambill
Electrochemistry Defines Oxidative Corrosion . 125
R. V. Jelinek

Engineering

Vol. 65, No. 17

DESIGN NOTEBOOK

Eductor Cuts Noise of Live Steam Heating.... 131
Javier F. Kuong

Read Time Direct in Decimal Units..... 131
H. J. Ramey, Jr.

Graph for Van Laar Constants..... 132
Benjamin C. Y. Lu, B. A. Lavergne

YOU AND YOUR JOB

Nationwide Job Pools Place Professionals..... 133

OPERATION & MAINTENANCE

Fluid Agitation in Tank Cars..... 136
Robert L. Bates

CORROSION FORUM

Foamed Silica: Hard-to-Beat Properties..... 142

Other Regular Features

Petrochemicals & Petroleum Refining Index.... 5
Firms in the News 148
Convention Calendar 152
More New Equipment Developments..... 154
Technical Bookshelf 160
Letters: Pro & Con 162
Classified Section 181
Equipment Searchlight 182

Reader Service

Guide to Technical Literature 164
Reader Service Postcard 171
Reprints Now Available 173
Advertisers in This Issue 186

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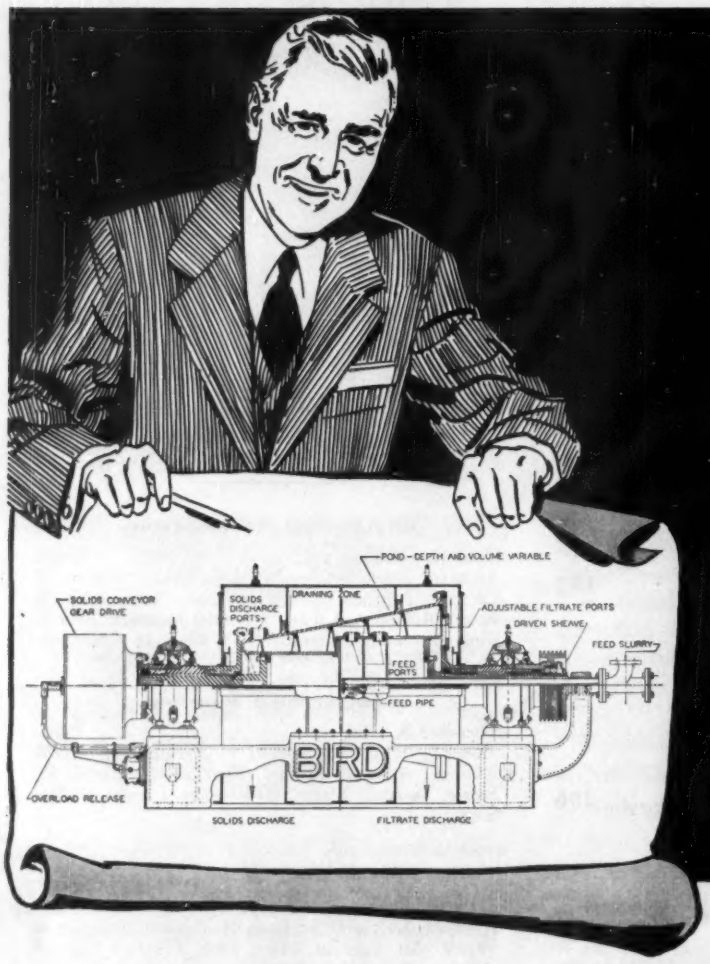

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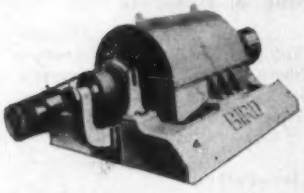

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Chemical Engineering

This issue's top features in ...

Petrochemicals & Petroleum Refining

AUG. 25, 1958

Also of Basic Interest
Chementator 51
Processes & Technology
Tall-Oil Plant 58
Hydrogenator 64
Chemical Economics
Inflation 70
Process Flowsheet
Uranium 104
Feature Articles
Hot Carbonate 113
Waste Dispoal 117
Prandtl Number 121
Oxidative Corrosion ..125
Design Notebook 131
You & Your Job
Job Specialist 133
Operation & Maintenance
Tankcars 136
Corrosion Forum
Foamed Silica 142
Firms in the News.....148
Calendar 152
More New Equipment....154
Technical Bookshelf 160
Letters Pro & Con.....162
Technical Literature 164

Tall-oil plant reflects refining know-how..... 58

To fractionate heat-sensitive tall oil, this plant puts some interesting process twists on a fairly standard splitting route, cuts heat needs and equipment size.

Hydrogenator converts heavy oil to fuel gas..... 64

Developed to broaden raw-material base of Britain's fuel-gas supply, non-catalytic, fluid-bed process is now slated for commercial use at three British sites.

What's the economic picture at this time?..... 70

Here are some noteworthy straws in the economic wind: New investment yardstick can help you map modernization. And: NPA survey on atom power is conservative.

Try hot carbonate for acid gas removal..... 113

Hot potassium carbonate solution can prove less costly than amine treatment in removing large amounts of acid constitutents from gases. Several plants now use it.

Checkup on fluid mixing in tankcars..... 136

There are new possibilities for fluid mixing in tankcars. But tank design makes mixing a special problem. Here's a rundown on what to use and how.

Chemical Engineering (with Chemical & Metallurgical Engineering) is published biweekly by McGraw-Hill Publishing Company, Inc., James H. McGraw (1860-1948), Founder. Publication Office: 99-129 North Broadway, Albany 1, N. Y. **Executive, Editorial, Circulation and Advertising Offices:** 330 West 42nd St., New York 36, N. Y. Donald C. McGraw, President; Joseph A. Gerardi, Executive Vice President; L. Keith Goodrich, Vice President and Treasurer; John J. Cooke, Secretary; Nelson Bond, Executive Vice President, Publications Division; Ralph B. Smith, Vice President and Editorial Director; Joseph H. Allen, Vice President and Director of Advertising Sales; A. R. Venezian, Vice President and Circulation Coordinator.

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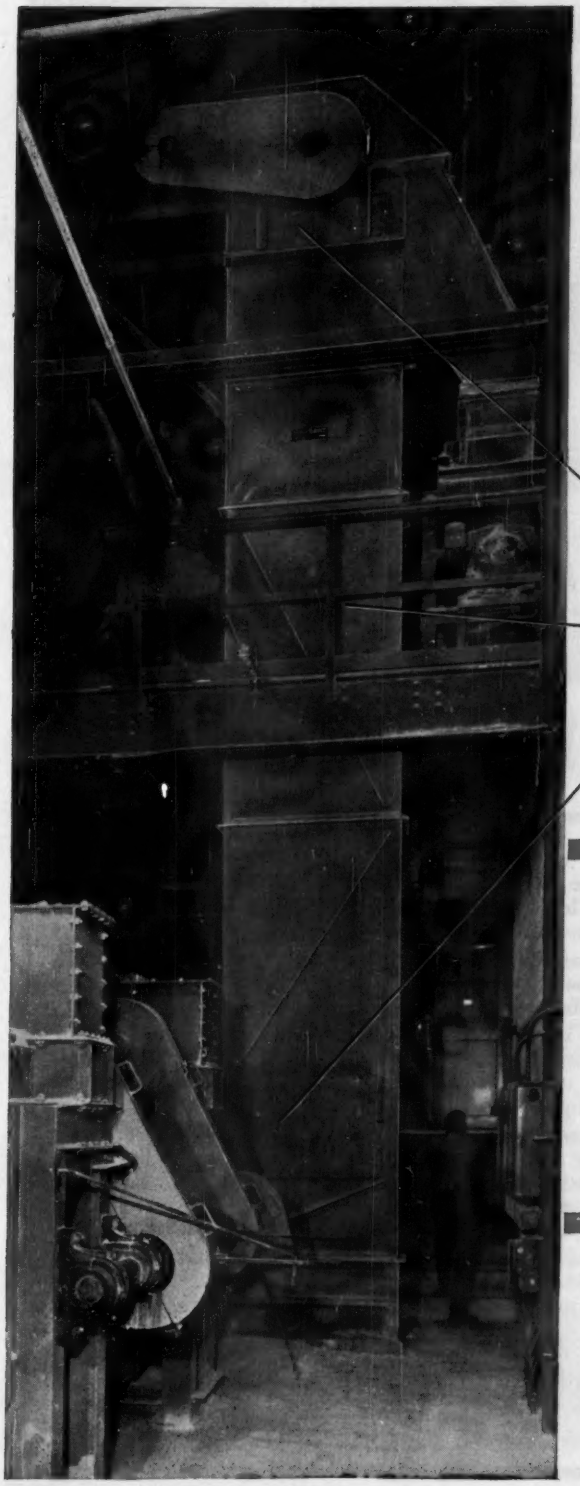

Link-Belt makes and integrates all components to speed assembly

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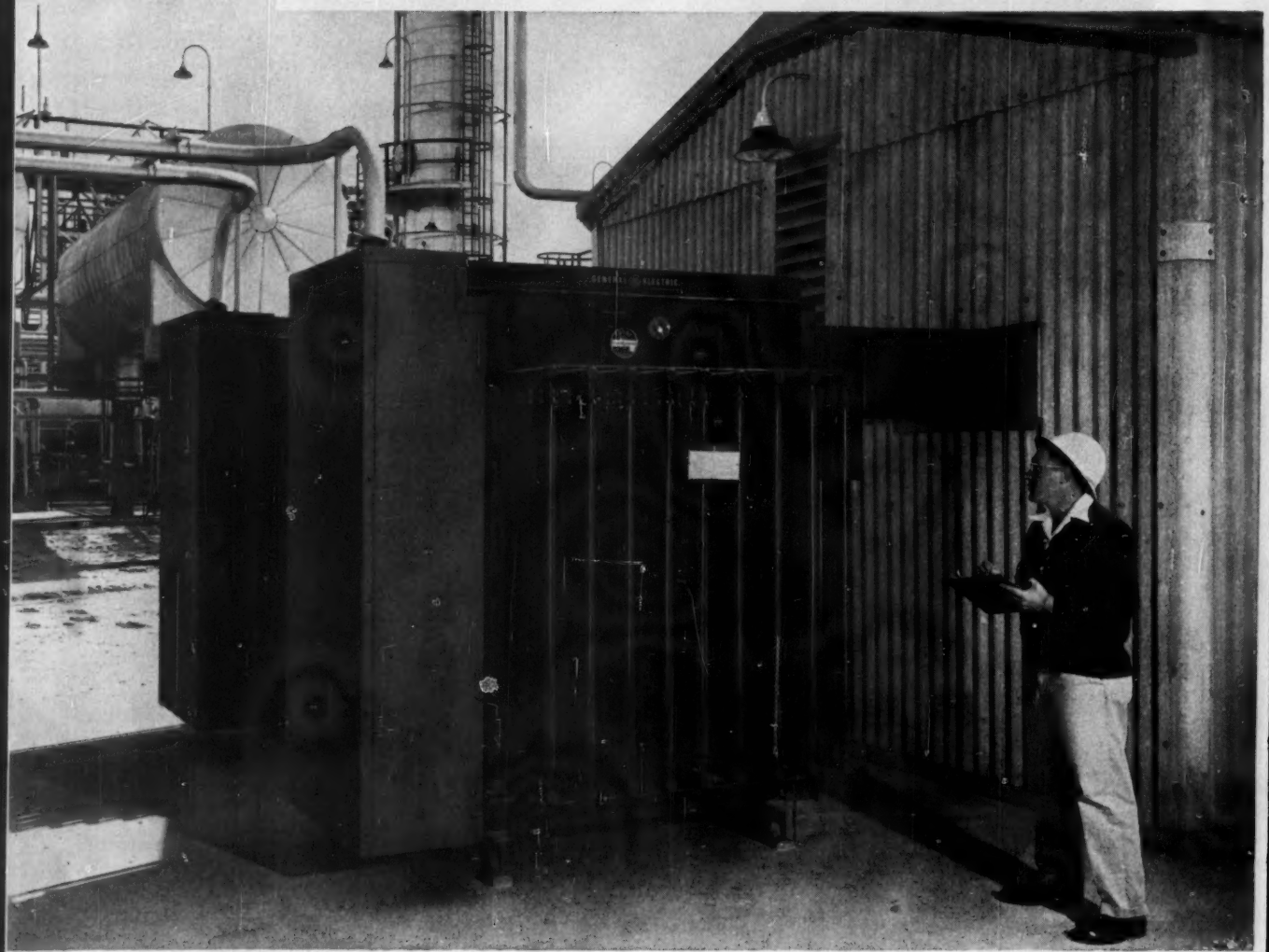
At W. R. Grace and Co.'s new polyolefin plant . . .



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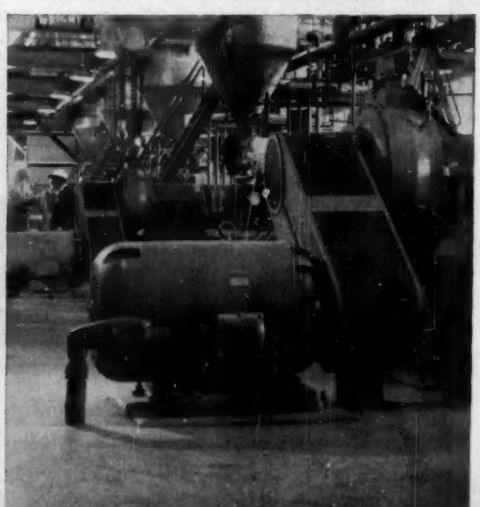

Standardization on General Electric equipment cut spare parts inventory by 60%

OPERATION upturn — Buy now for extra values — GENERAL ELECTRIC

Here's how single-source purchasing and expert system-engineering assistance cut installation time and costs, and saved valuable floor space for the Polymer Chemicals Division of W. R. Grace and Co.

Because standardization on General Electric motors, controls and switchgear permitted maximum parts interchangeability, W. R. Grace and Co., reduced anticipated spare parts inventories by 60 per cent at their new Baton Rouge polyolefin plant. Now, spare parts for their entire electrical system occupy less than 1 per cent of their warehouse area, making valuable space available for production items.

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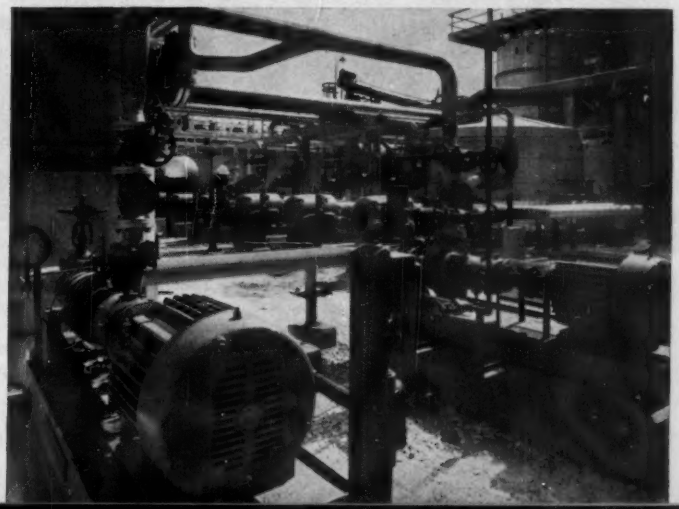

Life on the Chemical Newsfront

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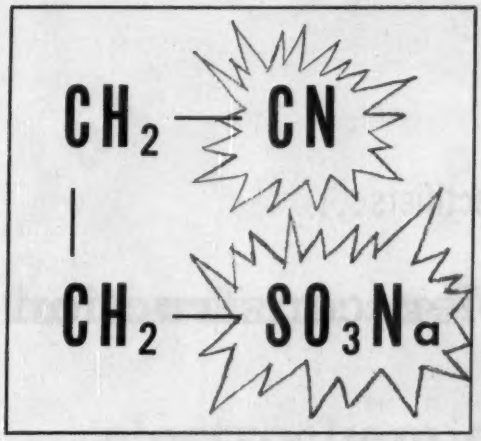

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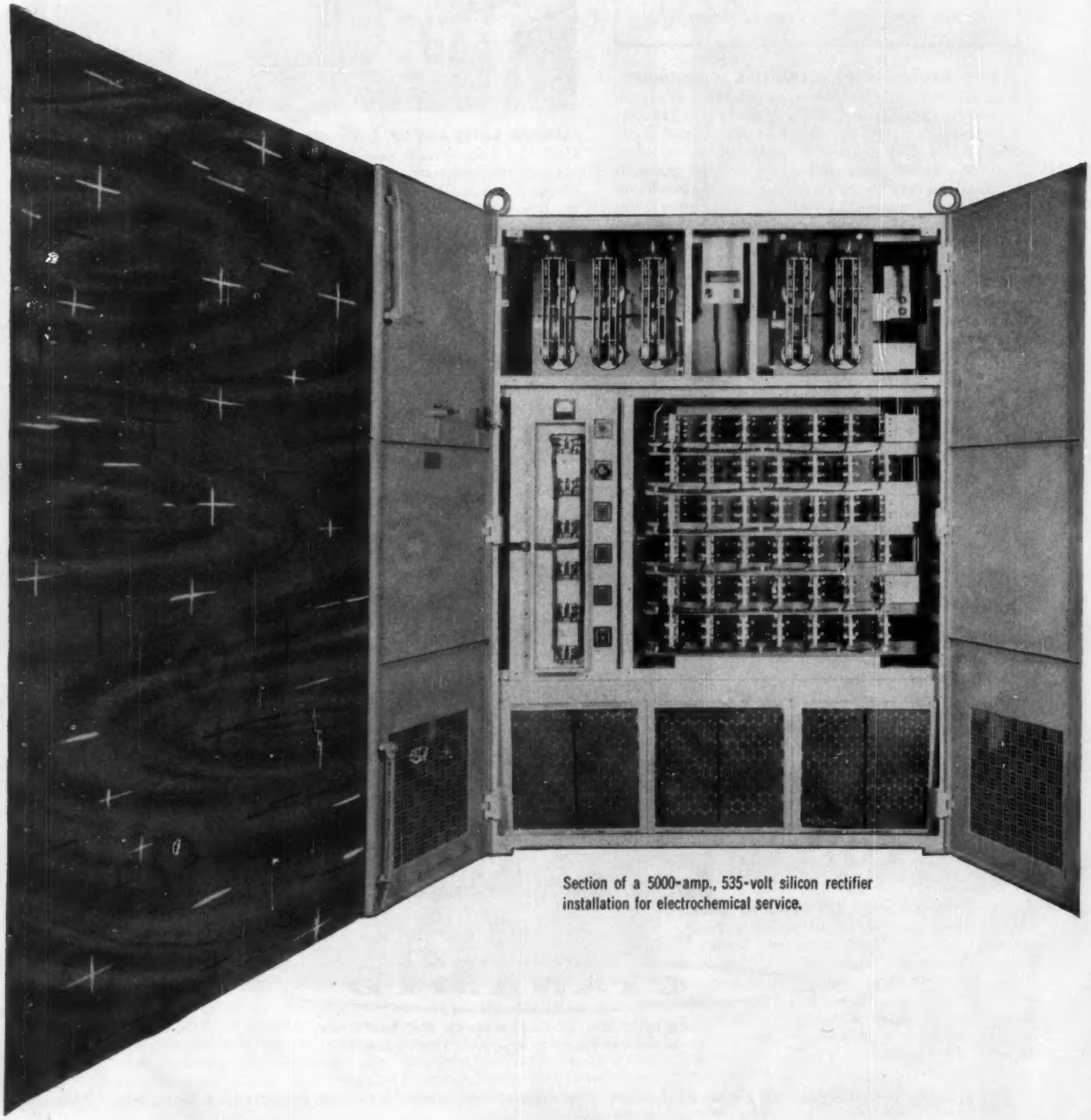
Westinghouse Silicon Rectifiers...

higher efficiency, simpler construction



Section of a 5000-amp., 535-volt silicon rectifier installation for electrochemical service.

for medium and low voltage

electrochemical processing economy

Helping you curb the high cost of processing is the job of these new air-cooled, high-efficiency Westinghouse silicon rectifiers. Cost of power — as reflected in final product costs — is now made lower than ever before.

Low cost . . . advanced circuitry eliminates complicated excitation equipment and simplifies construction.

High efficiency . . . approximately 95% overall, for low and medium voltage applications.

Long life . . . no detectable aging of silicon cells has occurred even after many years of use.

Ease of installation . . . units are completely factory-assembled. You need only make a-c and d-c connections.

No costly outages . . . indicating equipment will detect cell failure. Drawout construction makes replacement quick and easy without dropping load.

For full information on Westinghouse silicon rectifiers for electrochemical applications, call your Westinghouse representative or write Westinghouse Electric Corporation, P.O. Box 868, Pittsburgh 30, Pennsylvania. J-15008

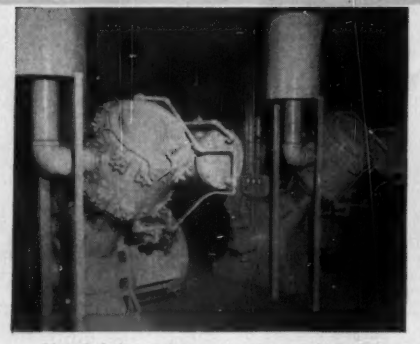
YOU CAN BE SURE...IF IT'S Westinghouse

TYPE Y COMPRESSORS

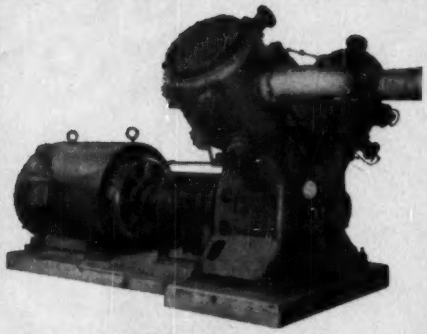
- *75 to 250 horsepower*
- *For vacuum service and pressures to 5,000 pounds*
- *One to four stages of compression*
- *Built-in motor, coupled, and belt drive*
- *Simple, compact, widely adaptable, heavy-duty*
- *Built for "round-the-clock service" with minimum of attendance*

word for the Y's...

Four-stage high pressure unit available with flange-mounted, belted, or coupled drive.



Non-lubricated, two-stage compressor, with built-in motor, provides oil-free air for process work.



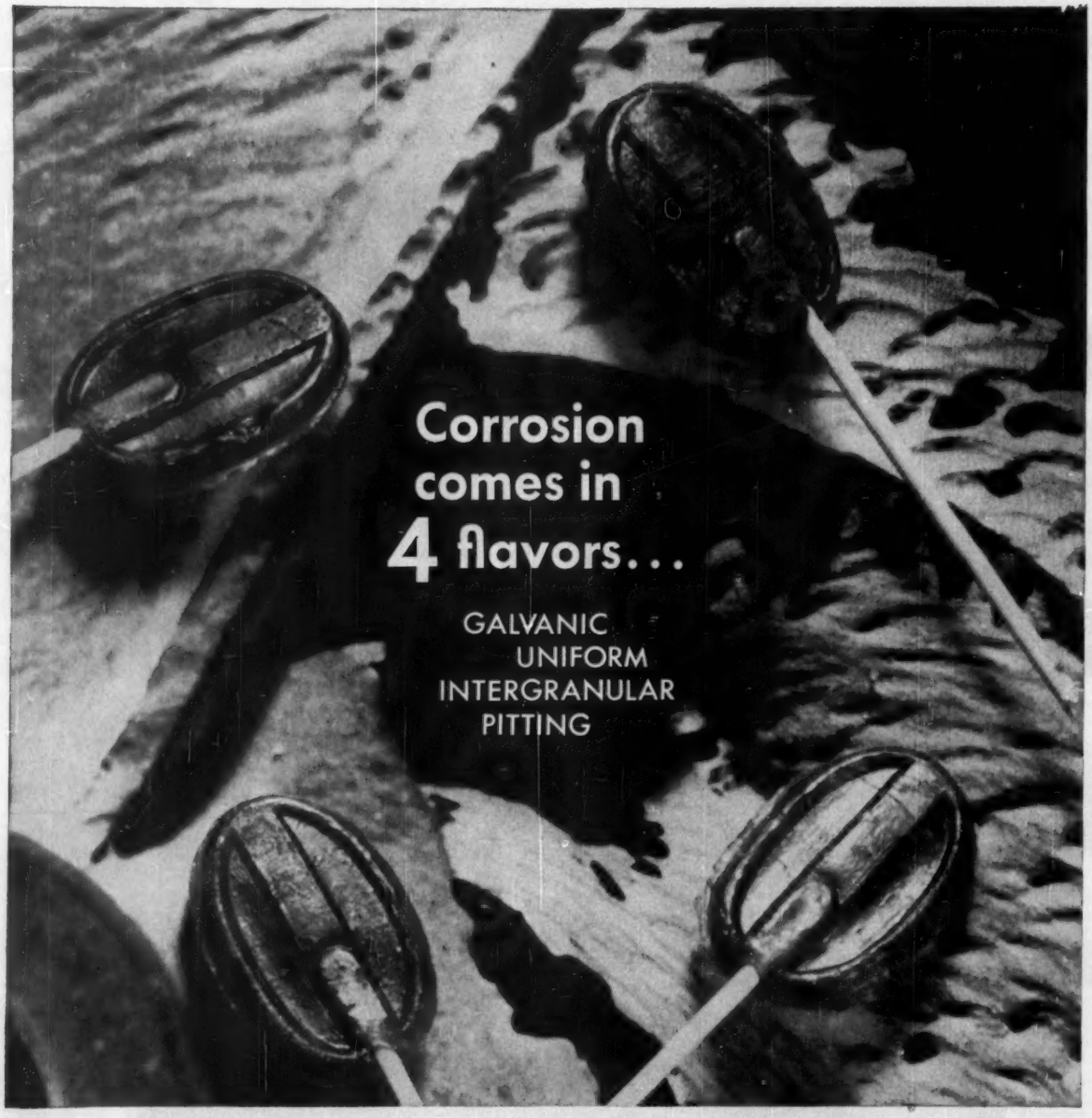
Butane compressor, direct coupled to an explosion-proof motor, in a prominent refinery.

THEY'RE ADAPTABLE

★ OTHER TYPE COMPRESSORS AVAILABLE
IN SIZES TO 5000 HP AND PRESSURES TO 15,000 PSIG.

Chicago Pneumatic 8 East 44th Street, New York 17, New York

AIR AND GAS COMPRESSORS • VACUUM PUMPS • PNEUMATIC TOOLS • ELECTRIC TOOLS • DIESEL ENGINES • ROCK DRILLS • HYDRAULIC TOOLS

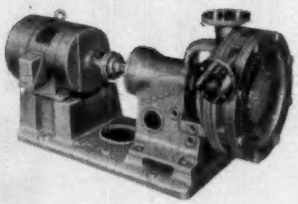


Which ones do *you* want licked?

They're all sour—when you have to pump corrosives. You can lick all four when your pump is made of the right materials.

You know what you have to pump. We know how to furnish pumps to handle it.

We'd like to hear your problem.



GOULDS-PFAUDLER GLASSED PUMP. Here's a unique new centrifugal pump that joins the unexcelled corrosion resistance of Pfaudler glass to the sturdy construction of Goulds pumps. For complete details, send for our Bulletin 725.2.

GOULDS

PUMPS FOR INDUSTRY

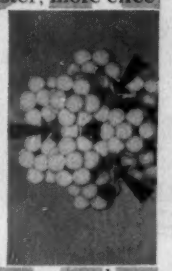
GOULDS PUMPS, INC.
Dept. CE-88, Seneca Falls, N.Y.
Main Office and Works

Branches and Representatives in all principal cities

CREATIVE ENGINEERING • INTEGRATED MANUFACTURING • ENGINEERED APPLICATIONS

Chemical-Loaded Molecular Sieves—Latent Curing Aids in Rubber and Plastics

Rubber and plastics fabricators need faster curing systems. The use of more active agents for rapid curing reactions has been restricted, because their use generally results in formulations difficult to process and store. This problem is serious at the high temperatures reached during the processing of rubber formulations. A novel series of latent curing aids, called LINDE Chemical-Loaded Molecular Sieves, now make it possible to use these active compounds to obtain faster, more effective curing systems, while still maintaining processing safety.



In LINDE Chemical-Loaded Molecular Sieves curing aids are "locked" within the pore structure of the Molecular Sieves by strong adsorptive forces. The active compounds, when loaded on Molecular Sieves, are effectively isolated from the rubber or resin formulation during processing and storage. However, at curing temperatures, which are generally higher than processing temperatures, the active compound is released from the Molecular Sieve to accelerate the curing reaction.*

In this way, Loaded Molecular Sieves permit the use of highly active compounds to obtain fast cures, without sacrificing processing safety or pot life. Now, even vulcanization agents previously considered too active or volatile for practical use, may be used with processing safety.

Chemical-Loaded Molecular Sieves can be used as latent accelerators and curing agents in a variety of rubber and plastics formulations including styrene-butadiene rubber, natural rubber, Neoprene, nitrile rubber, epoxy resins, rigid vinyl plastisols and others. Loaded Molecular Sieve CW-2015 (di-tertiary butyl peroxide) is being used commercially in the curing of silicone elastomers and rigid vinyl plastisols. Loaded Molecular Sieves are now being investigated by many processors of rubber and plastics in such items as tires, mechanical goods, hose, belting and footwear. For further data, write to Molecular Sieves Department CG-83, LINDE COMPANY, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y.

Radioactive Krypton

Krypton 85 is a radioactive isotope of the inert atmospheric gas, with a half-life of 9.4 years.

Radioisotopes such as Kr-85 are relatively inexpensive and new uses for them are being found every day.

One application is in tracer element testing of hermetically sealed encapsulated transistor devices. Another is in an "external" non-electric illuminating lamp which uses Kr-85 to activate a phosphor coating on the inside of a glass globe. Studies at the National Institutes of Health have shown that Kr-85 can be used to detect abnormal heart openings. 99 per cent of Kr-85 radiation is non-penetrating, quite safe, even for repeated exposures.

LINDE is marketing Kr-85 as an additive to non-radioactive rare gases (argon, helium, neon, krypton and xenon) individually or as mixtures. LINDE does not sell Kr-85 in pure or concentrated form. The other rare or inert gases, with Kr-85 added, will normally be available only in Atomic Energy Commission-approved, specially-marked cylinders.

Purchasers must be licensed by local or regional A.E.C. offices except for purchases of one microcurie or less. Non-licensed purchasers of one microcurie each may have 10 such cylinders on hand at a time.

LINDE's price for Kr-85 additions will be based on the radioactive level of the gas mixture expressed in millicuries of activity (N.T.P.) per liter. For additional information, write to Rare Gas Department CG-83, LINDE COMPANY, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y.

Three-Level Ruby Maser

The Maser is a microwave amplifier utilizing energy stored in a molecular or atomic system. Emission of this energy is stimulated by the input signal. Masers operate at liquid helium temperatures and have incredibly low noise levels approaching zero db. Recently a University research laboratory* used

LINDE single crystal synthetic ruby (Al_2O_3 with Cr_2O_3 additive) in a three-level solid state Maser. The ruby crystal was placed at the center of the Maser's tuned cavity and a magnetic field of 4200 gauss was applied. To bring electrons from a ground state into a permissible higher energy level, a pumping frequency of 24 kMc was used and the Maser successfully amplified signals at 9.3 kMc.

LINDE also supplies other crystals including rutile, spinel and sapphire (Al_2O_3). Sapphire is used in infrared optical systems, windows for high power microwave tubes, spacers and supports in vacuum tubes, radiation pipes. It has strength at elevated temperatures, melts at 2040°C, is hard, inert, nonporous and can be sealed to metals and glasses. Sapphire is currently available in the shape of domes, windows up to 4½ inches in diameter, rods and special configurations.

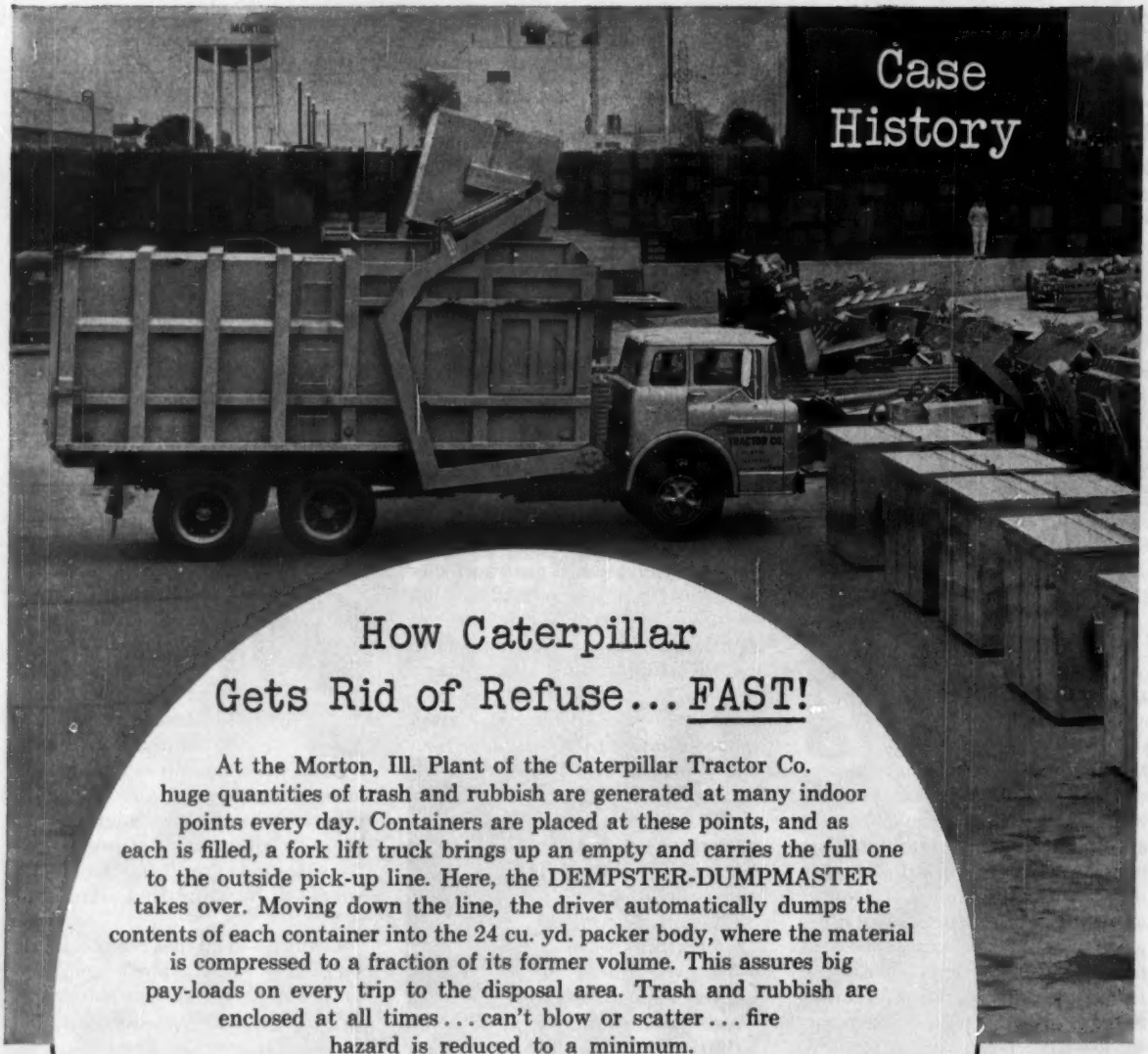
For further data write to Crystal Products Department CG-83, LINDE COMPANY, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, New York.

*"Maser Action in Ruby," by G. Makhov, C. Kikuchi, J. Lambe, and R. W. Terhune. "Physical Review," Volume 109, Number 4, Page 1399, Feb. 15, 1958.

PRODUCTS WITH A FUTURE

Linde TRADE-MARK UNION CARBIDE

The terms "Linde" and "Union Carbide" are registered trade-marks of Union Carbide Corporation.



How Caterpillar Gets Rid of Refuse... FAST!

At the Morton, Ill. Plant of the Caterpillar Tractor Co. huge quantities of trash and rubbish are generated at many indoor points every day. Containers are placed at these points, and as each is filled, a fork lift truck brings up an empty and carries the full one to the outside pick-up line. Here, the DEMPSTER-DUMPMASTER takes over. Moving down the line, the driver automatically dumps the contents of each container into the 24 cu. yd. packer body, where the material is compressed to a fraction of its former volume. This assures big pay-loads on every trip to the disposal area. Trash and rubbish are enclosed at all times... can't blow or scatter... fire hazard is reduced to a minimum.

THE DEMPSTER-DUMPMASTER

The DEMPSTER-DUMPMASTER is economical! One-man operation. Big pay-loads from 50 to 100 cubic yards. It's safe! Clearance lifting arms never pass the cab windows, can't injure the operator. It's versatile! Handles containers below grade or from docks. Can be used for manual loading routes. Containers available in one through six cubic-yard capacity, with or without casters.

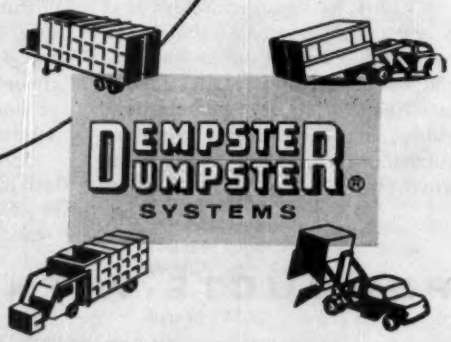
Mfd. By
Dempster Brothers
Inc.

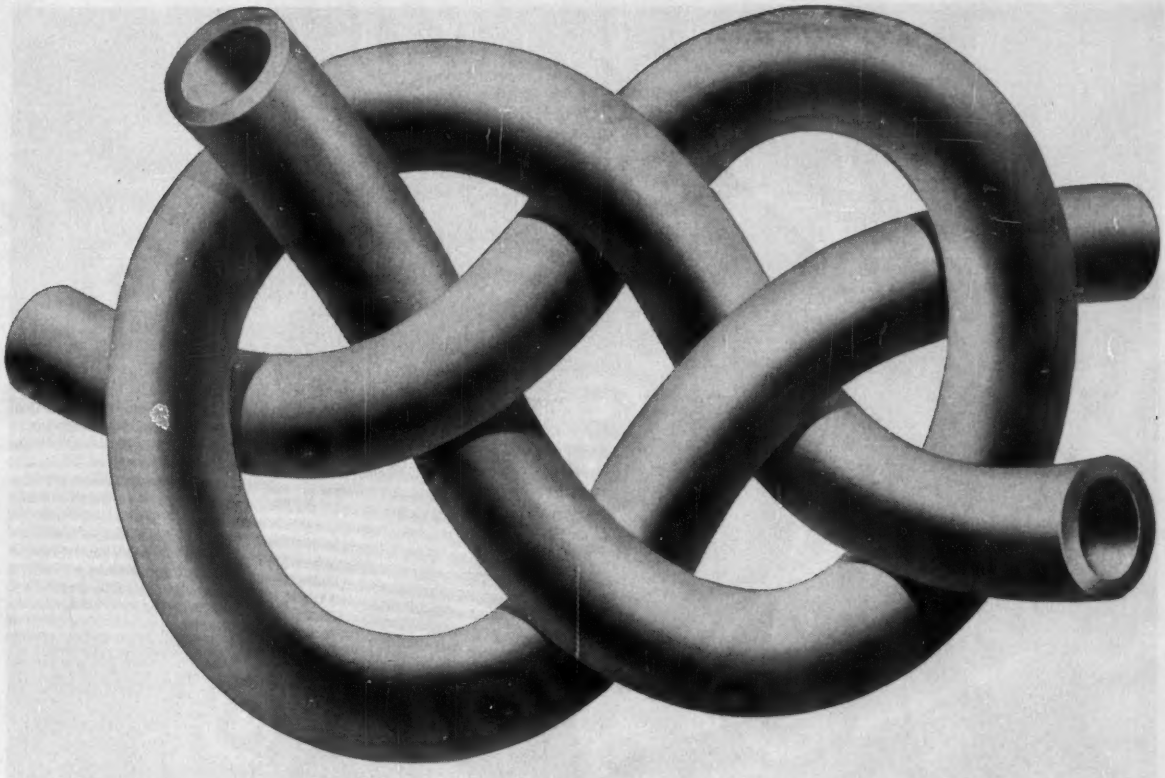
Dept. CE-8, DEMPSTER BROTHERS, Knoxville 17, Tenn.

WRITE TODAY FOR FREE BOOK

Dept. CE-8, Dempster Brothers, Knoxville 17, Tenn.
Please send without obligation your new booklet, "How to Cut Waste Disposal Costs."

Name_____ Title_____
Firm_____
Address_____
City_____ State_____





Knotty pressure tube problems?

Let Timken Company metallurgists select the one steel analysis that gives you maximum tube life per dollar

IF cost weren't a factor, you could choose from a number of high temperature steels to handle your pressure, temperature and corrosion problems. But to get the greatest economy means finding the *one* steel analysis that gives you the longest tube life per dollar.

That's where Timken Company metallurgists can help you. They're recognized experts in high temperature steels, with over 25 years of research and production experience. They've solved hundreds of industry's most difficult pressure tube problems. And they've done it economically.

There's no problem in getting the right steels, either. You can get Timken® seamless pressure tubes in sizes up to 11″ O.D. x 3″ wall. They're available in all stainless and alloy grades to meet almost any combination of operating conditions. Composition is exact because we make only electric furnace fine alloy steel. And through rigid quality control, the steel is uniform from heat to heat, tube to tube, order to order.

To untie your knotty pressure tube problems *and* save money, call on Timken Company metallurgists. The Timken Roller Bearing Company, Steel & Tube Division, Canton 6, Ohio. Cable address: "TIMROSCO".

TIMKEN *Fine Alloy* **STEEL**

TRADE-MARK REG. U. S. PAT. OFF.

SPECIALISTS IN FINE ALLOY STEELS, GRAPHITIC TOOL STEELS AND SEAMLESS STEEL TUBING

Solar builds big and small joints for Dresden Nuclear Power Station

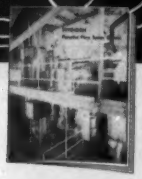
FROM PRECISION BUILT JOINTS ½ in. in diameter . . . to the world's largest . . . Solar offers the *right* expansion joint for every piping need. Shown above are only two of the joints which will go into the $45 million Dresden Nuclear Power Station in Illinois. The larger joint—16 ft in diameter—will absorb differential expansion between a concrete housing and a steel cavity in which nuclear activity takes place. The smaller joint is among several which will serve as a seal on piping for contaminated material.

Solar manufactures the most complete line of expansion joints in the world. They are made from a wide variety of stainless and high-temperature alloys in a complete range of sizes. Temperatures range from −320F to 1200F, pressures from complete vacuum to 600 psi and up. *And rugged, economical Sola-Flex® joints can be "in service" one to four weeks after receipt of order!*

A new pamphlet describes Solar's complete line of Sola-Flex expansion joints. Write for it to Dept. F-56, Solar Aircraft Company, San Diego 12, Calif.

SOLAR AIRCRAFT COMPANY — SAN DIEGO, DES MOINES

Swenson processing equipment means quality to our customers round-the world



Send for your copy of the new full-color Bulletin SW 401, "Swenson Parallel Flow Spray Dryers." Write Swenson Evaporator Company, 15669 Lathrop Avenue, Harvey, Illinois.

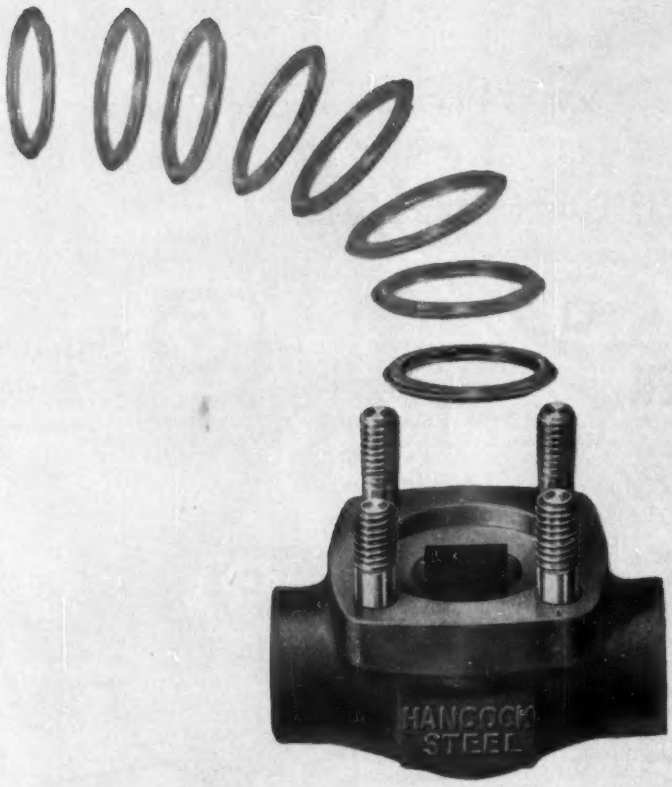
87 OF AMERICA'S "FIRST HUNDRED" CORPORATIONS ARE WHITING CUSTOMERS

SWENSON

Proved Engineering for the Process Industries Since 1889

A Division of WHITING Corporation

WHITING—MANUFACTURERS OF CRANES; TRAMBEAM HANDLING SYSTEMS; TRACKMOBILES; FOUNDRY and RAILROAD EQUIPMENT



RING OF STEEL

Defies Pressure Times Ten

The Flexitallic gasket in the bonnet joint of Hancock Steel Gate Valves cannot blow out even if pressures exceed ten times the rating of the valve. Valve maintenance and equipment down-time are greatly reduced. Made of a spiral-wound ribbon of stainless steel with asbestos filler, the gasket has spring-like compressibility — cannot be flattened.

Only the specially-designed Hancock bonnet joint with built-in compression limit can make full use of the positive sealing power of this ring of steel. Such advanced valve engineering is one example of total Hancock quality that assures trouble-free performance. Your nearby industrial supply distributor will gladly explain every economy feature of Hancock Steel Gate Valves. Phone him today.

Hancock 800# Steel Gate Valve, Type 950. Sizes: ¼" thru 2".

HANCOCK STEEL VALVES

A product of

MANNING, MAXWELL & MOORE, INC.

Consolidated Ashcroft Hancock Division • Watertown, Massachusetts
In Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario

Emery NEWS

WEIGHING SYSTEM

BIN, TANK AND HOPPER EDITION No. 10

Covering design, development and application data on Emery Weighing Systems for industrial applications.

ANNOUNCING THE NEW WAY-PAC* LINE OF LOW-CAPACITY LOW-PRICE PACKAGED SYSTEMS FOR TANK WEIGHING

SIMPLICITY OF SELECTION AND OPERATION IS KEY FEATURE OF SUPPLEMENTARY LINE

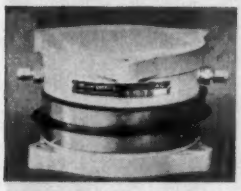


FIG. 1 TYPE AC-1 CELL COMPRESSION.

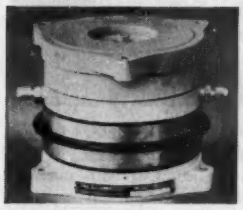


FIG. 2 TYPE AC-1 "ROLLING-BALL" CELL.

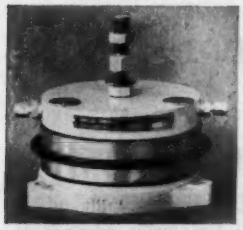


FIG. 3 TYPE AD-1 CELL DYNAMOMETER.

FIG. 4 TYPE AT-1 CELL TENSION.

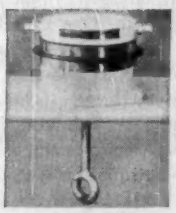


FIG. 5 TYPE AU-1 CELL TENSION.

The WAY-PAC, a new line of Emery low-capacity, low price packaged hydraulic tank weighing systems, designed specifically for the 0 to 1000 lb. range, is now being offered to the process industries.

The accuracy of the WAY-PAC cells is ¼ of 1% of range. This extreme accuracy depends upon two significant design features . . . a moulded rubber diaphragm which maintains a constant acting area and a rolling ball assembly which performs the dual function of practically eliminating friction in the "piston-cylinder" assembly as well as preventing deleterious pinching of the diaphragm in the event of cross loading.

Five different cell types are available in the WAY-PAC line, each designed to perform with typical Emery excellence under different sets of operating conditions. (See Figs. 1 to 5).

The cells are manufactured of aluminum and a top grade bar stock steel to eliminate any possible leakage of the film of oil sealed in the diaphragm.

Unique design features, coupled with the ultimate in manufacturing craftsmanship, have produced in the WAY-PAC line equipment capable of long service life with extreme accuracy under the most rigorous conditions.

A complete line of related equipment is available including: tank pivots, strut assemblies, indicators and recorders. Although controlling and printing equipment can be supplied with and can be operated from the WAY-PAC cells, it is desirable that our engineers know the details of the installation in order to make a recommendation.

*Trademark

Moulded Rubber Diaphragm Gives Constant Acting Area

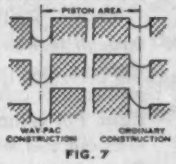


FIG. 7

The moulded rubber diaphragm used in the WAY-PAC cells possesses a unique "rolling action" which imparts constant acting area to the cell. This "rolling action" is illustrated in Fig. 7.

Because of this constant "rolling action", the Emery WAY-PAC load cell is extremely and consistently accurate.

Exclusive "Rolling Ball" Head Available in WAY-PAC LINE

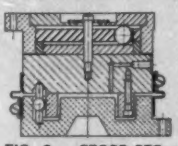


FIG. 6 CROSS SECTION OF "ROLLING-BALL" CELL.

To prevent damage from possible crosswise movement of the tank, bin, hopper or structure being weighed, we have incorporated into the WAY-PAC cell line the exclusive Emery "rolling ball" head.

In essence, the WAY-PAC "rolling ball" head consists of three ½" diameter stainless steel balls built into the top platen of the cell, riding top and bottom on hardened steel plates. (See Fig. 6). In operation, any crosswise movement, such as that incurred in the expansion and contraction of the structure being weighed, rides on the stainless steel balls and is transmitted through them to the diaphragm.

Load cells which do not take expansion and contraction into consideration are not properly designed and cannot compare with the WAY-PAC.

NEW WAY-PAC BULLETIN 582 AVAILABLE FOR DISTRIBUTION

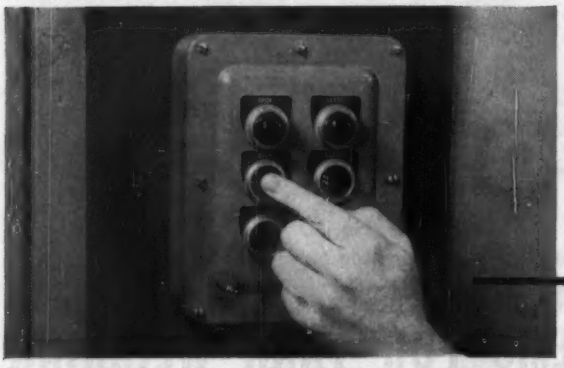
Our new Bulletin 582 which describes in detail the Emery WAY-PAC line and provides an easy-to-use method of figuring your system costs is now off the press. Send for your copy right away.

PRECISION SINCE 1872

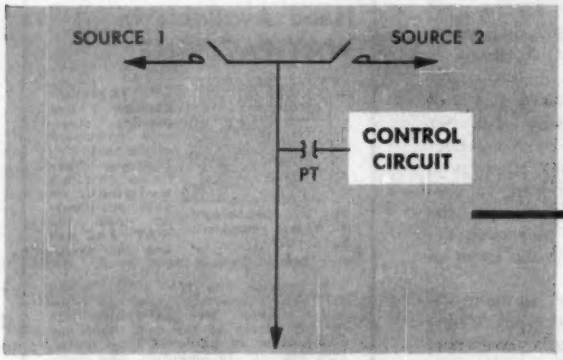
THE A. H. EMERY COMPANY

Pine Street • New Canaan, Conn.

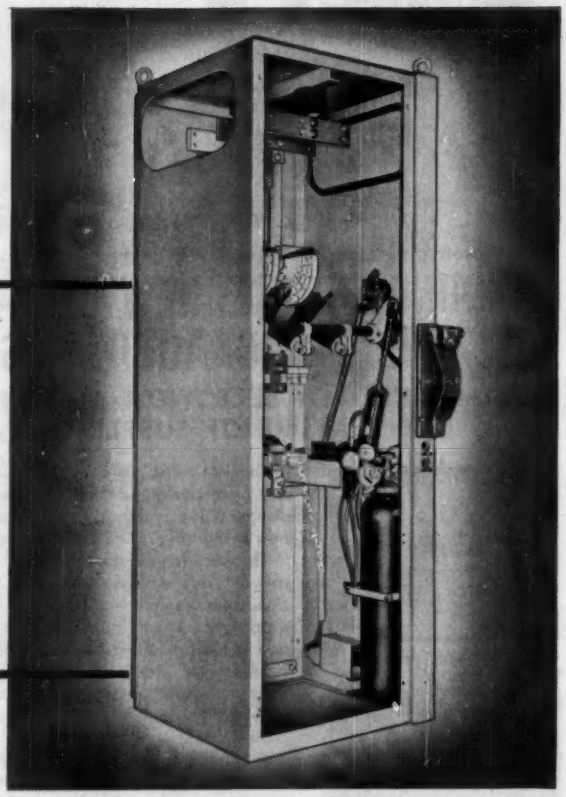
R&IE ELECTRO-PNEUMATIC OPERATOR



Remote-control pushbuttons for switches scattered throughout a plant, or in a number of plants, may be grouped on a single control panel.



Automatic control requires only the addition of relatively simple control circuitry. In the application shown above, the loss of preferred voltage provides the necessary signal for automatic throwover to the emergency source. Only one PT is required in the load circuit.



Electro-pneumatically operated HPL-C Interrupter Switch shown with fuses, phase barriers, and doors removed. Switch can close safely into faults up to a million kva with current limiting fuses. Maximum safety during maintenance is assured by a key interlock which prevents the fuse door from being opened while the switch is closed.

NOW! Lower-Cost Remote or Automatic Power Control

New electro-pneumatic operator provides pushbutton or fully automatic actuation of R&IE 4.8-14.4 kv interrupter switches

Now you can enjoy the efficiency and convenience of dependable remote or fully automatic power switching at a new low cost. The new R&IE electro-pneumatic operator, significantly less expensive than motor driven or hydraulic operators, gives you fast, safe, centralized control of interrupter switches located throughout a plant, or in many plants. Where you require automatic operation, suitable relay circuits can provide switch control as a function of overload, loss of voltage or other special condition.

Adequate power for either remote or automatic control can be supplied by a potential transformer. The energy required for positive, high speed switch actuation is developed by a solenoid controlled, double acting, heavy duty air motor located inside the switch cubicle. Pneumatic pressure is supplied by a standard nitrogen cylinder or by dry compressed air from the plant system. One cylinder contains sufficient pressure for at least 500 complete operations.

All new R&IE Interrupter Switches, in ratings from 4.8 through 14.4 kv and 600 through 2000 amp, can be supplied with an electro-pneumatic operator. Many existing switch installations can have electro-pneumatic operators added to them. For complete information, consult your nearest I-T-E sales office or write R&IE Equipment Division, Greensburg, Pa. In Canada: Eastern Power Devices Ltd., Port Credit, Ont.

I-T-E CIRCUIT BREAKER COMPANY
R & I E EQUIPMENT DIVISION • GREENSBURG, PA.

Stockpiling

...a continuing company policy established years ago

Stockpiling is a measure of service.

The government is stockpiling strategic materials for its long range defense program. Thus, it serves the citizenry. The producer of a raw material who as a company policy stockpiles also serves . . . serves its customers who in turn serve others by being able to count on a supply of the raw material in quantity.

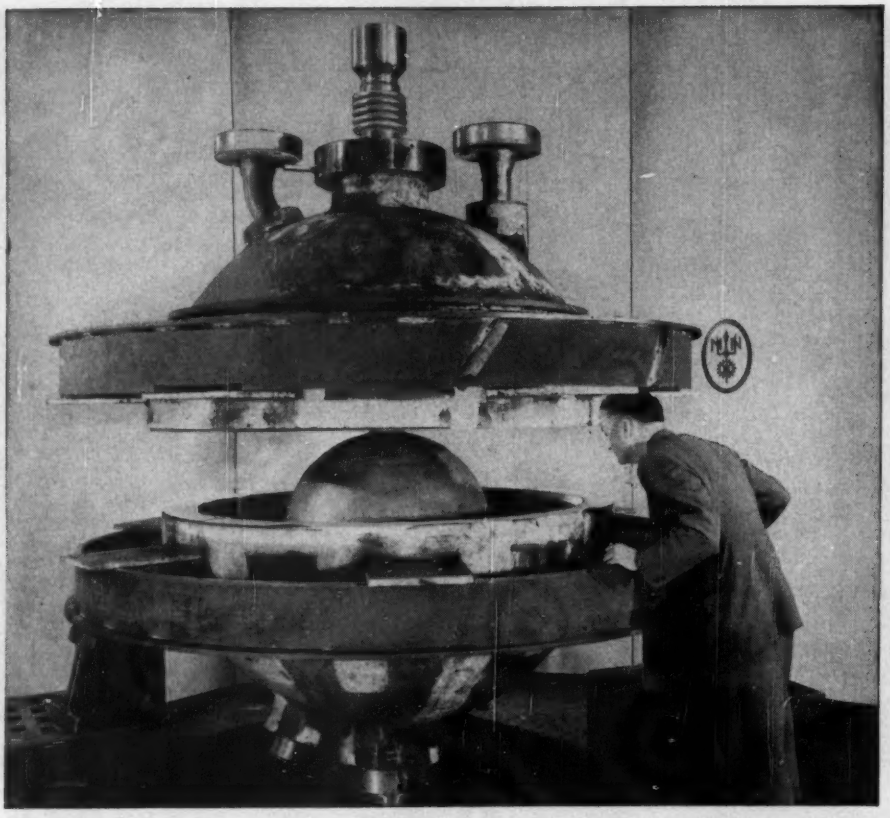
The policy of Texas Gulf Sulphur Company has always been to stockpile . . . always producing *extra* for the future. In spite of the growing demands for the important basic material it produces—Sulphur . . . the company's policy has been to keep on hand stocks equal to about a year's normal demand. With such a supply, it can make shipments, routine or emergency, of any tonnage, at any time, by any method.

Texas Gulf Sulphur Co.

75 East 45th Street, New York 17, N. Y.
811 Rusk Avenue, Houston 2, Texas

Sulphur Producing Units

Newgulf, Texas
Moss Bluff, Texas
Spindletop, Texas
Worland, Wyoming



Assembly of zircaloy-2 core tank and pressure vessel for Homogeneous Reactor Experiment No. 2 (HRE-2). The HRE-2 is a 5,000 KW plant designed for AEC by Union Carbide Nuclear Company. Newport News manufactured the 32" I.D. core vessel from 5/16" zircaloy-2, which involved the development of new welding techniques. The pressure vessel of Type 347 stainless clad steel is 4.4" thick, with an inner diameter of 60". Newport News designed the expansion joint between inner and outer vessels, and also produced the unusual coil-cooled blast shield for the unit.

Zircaloy-2 vessel produced by Newport News...for first two-region breeding homogeneous reactor

Never before had a pressure vessel been constructed from zircaloy-2.

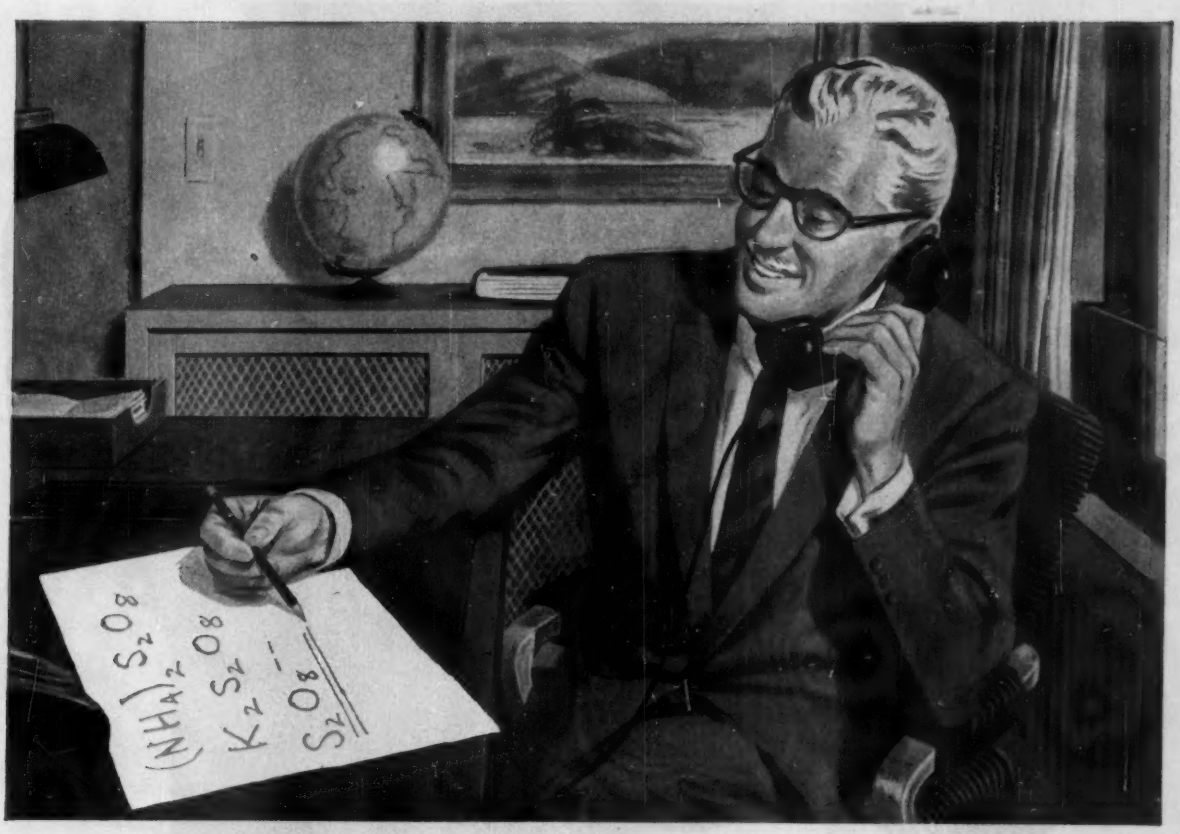
Extremely active chemically, particularly at elevated temperatures, this alloy challenged fabrication. Unshielded, heated zircaloy absorbs atmospheric gases in quantities that render its corrosion and physical properties unsatisfactory. Newport News, however, achieved consistent, satisfactory welds by use of inert gas and novel, plant-developed shielding.

The core tank contains the fuel region where fissioning produces heat. The blanket or reflector region around the tank is confined by a pressure vessel of stainless clad steel.

Newport News, working with its suppliers, developed special fabrication and welding techniques, as well as forge and rolling methods to produce plates and forgings with required corrosion, nuclear and physical properties for both vessels.

Make Newport News your source for fabricated metal structures. See how this company's high integration of skill and facilities can help you. Our illustrated booklet, *"Facilities and Products"*, is yours for the asking. Write for your copy now.

Newport News Shipbuilding and Dry Dock Company
Newport News, Virginia



Where can you use the unique characteristics of persulfates?

All peroxygens carry active oxygen in their molecules, but the persulfates offer these special properties as well: Unusually high oxidation potential, good resistance to catalytic decomposition, and a reactive anion that gives reactions quite different from those of other peroxide compounds.

You'll find persulfates have particular values in processes involving emulsion polymerization of monomers and depolymerization of organic polymers. Persulfates excel in such applications as processing color films, etching printing plates, and modifying starches; and are of interest as reactive oxidizing agents for many other purposes.

Perhaps *your* processing techniques can be improved through the use of Becco Persulfates. A Becco field engineer will be glad to discuss this with you, at no obligation . . . drop us a line. At the same time, ask for your free copy of these booklets:

Nos. 34 and 68, "Uses or Persulfates"

No. 63, "Action of Persulfates on 1, 2-Glycols"

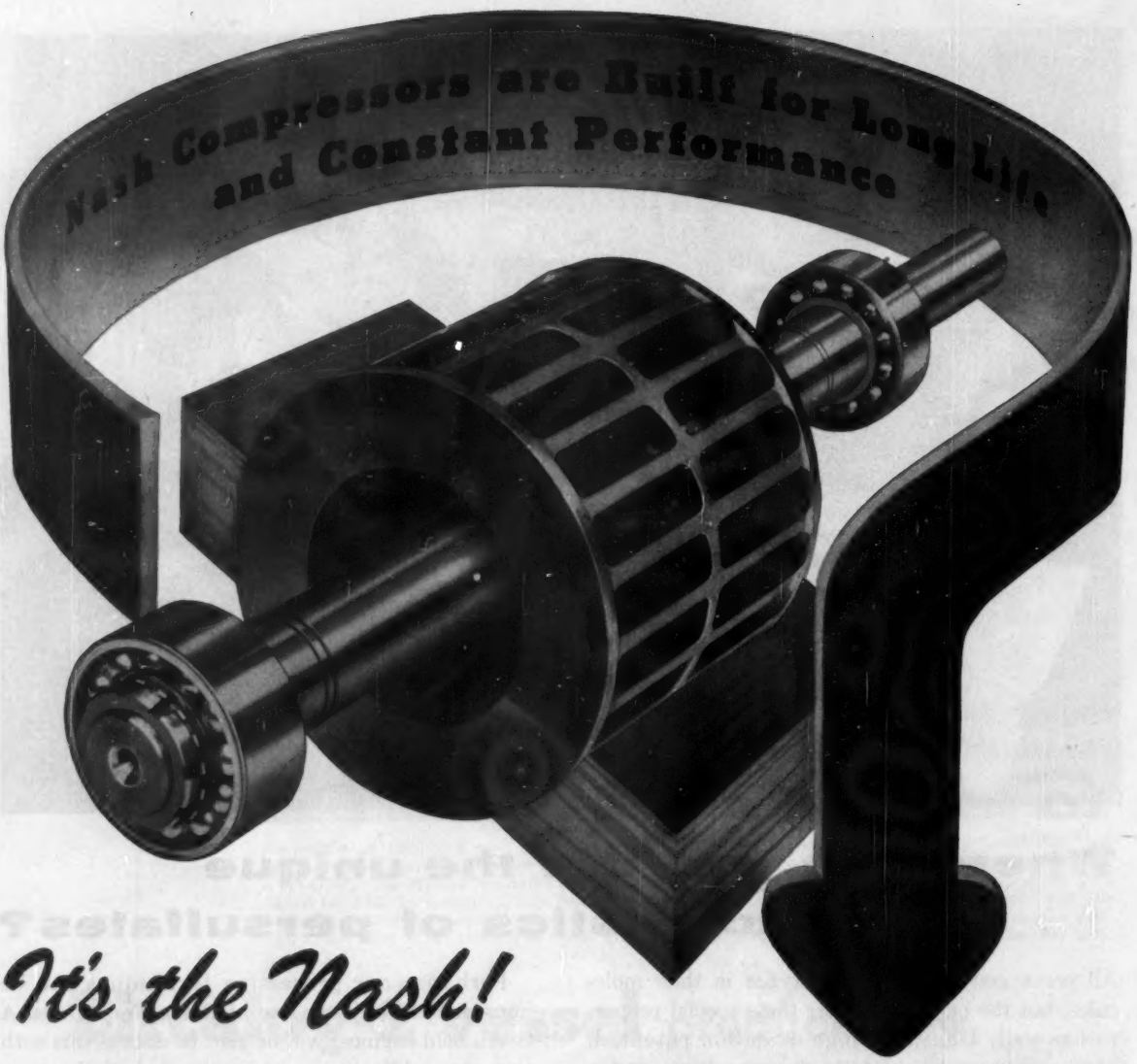
No. 90, "Etching of Printed Circuits with Ammonium Persulfate"

BECCO CHEMICAL DIVISION
Food Machinery and Chemical Corporation
Station B, Buffalo 7, New York

Progress in Peroxygens ® **BECCO**

fmc FOOD MACHINERY AND CHEMICAL CORPORATION ®

FMC CHEMICALS INCLUDE: BECCO Peroxygen Chemicals • WESTVACO Phosphates, Barium and Magnesium Chemicals • WESTVACO Alkalis, Chlorinated Chemicals and Carbon Bisulfide • NIAGARA Insecticides, Fungicides and Industrial Sulphur • OHIO-APEX Plasticizers and Chemicals • FAIRFIELD Pesticide Compounds and Organic Chemicals



It's the Nash!

The ability of Nash Compressors to maintain original performance over long periods is no accident. Nash Compressors have but a single moving element, the Nash Rotor. This rotor is precision balanced for long bearing life, and it revolves in the pump casing without metallic contact. Internal lubrication, frequent cause of gas contamination, is not employed in a Nash. Yet, these simple pumps maintain 75 lbs. pressure in a single stage, and afford capacities to 6 million cu. ft. per day in a single compact structure.

Nash Compressors have no valves, gears, pistons, sliding vanes or other enemies of long life. Compression is secured by an entirely different principle of operation, which offers important advantages often the answer to gas handling problems difficult with ordinary equipment.

Nash Compressors are compact and save space. They run without vibration, and compression is without pulsation. Because there are no internal wearing parts, maintenance is low. Service is assured by a nation-wide network of Engineering Service offices. Write for bulletins now.

No internal wearing parts.

No valves, pistons, or vanes.

No internal lubrication.

Low maintenance cost.

Saves floor space.

Desired delivery temperature Automatically maintained.

Slugs of liquid entering pump will do no harm.

75 pounds in a single stage.

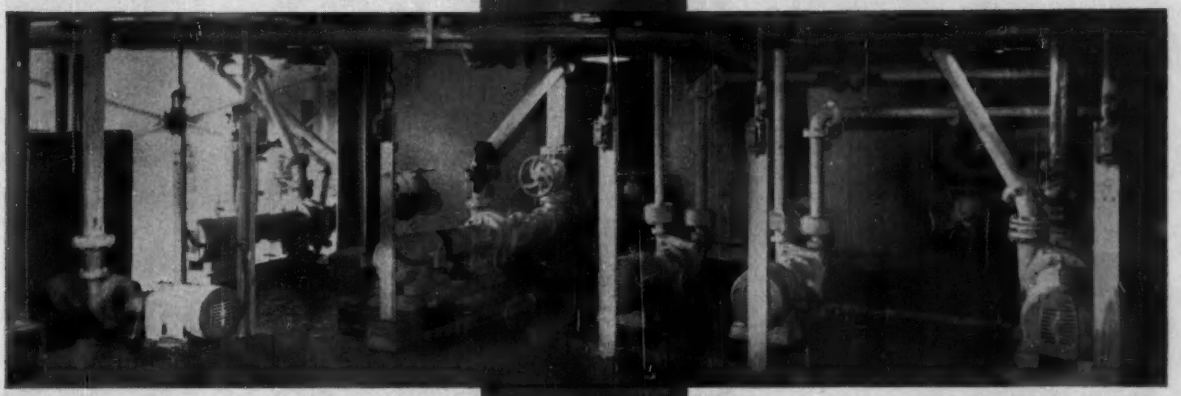
NASH ENGINEERING COMPANY

312 WILSON, SO. NORWALK, CONN.

WILFLEY
ACID PUMPS

HANDLING **CONCENTRATED PHOSPHORIC ACID** IN THIS NEW

200,000 ton-per-year **triple super-phosphate plant**



Wilfley Acid Pumps are a key factor in the successful operation of this largest single-stream phosphoric acid reaction system ever built. These famous pumps were chosen for their *lower maintenance costs and continuous, trouble-free operation.*

Individual Engineering on Every Application

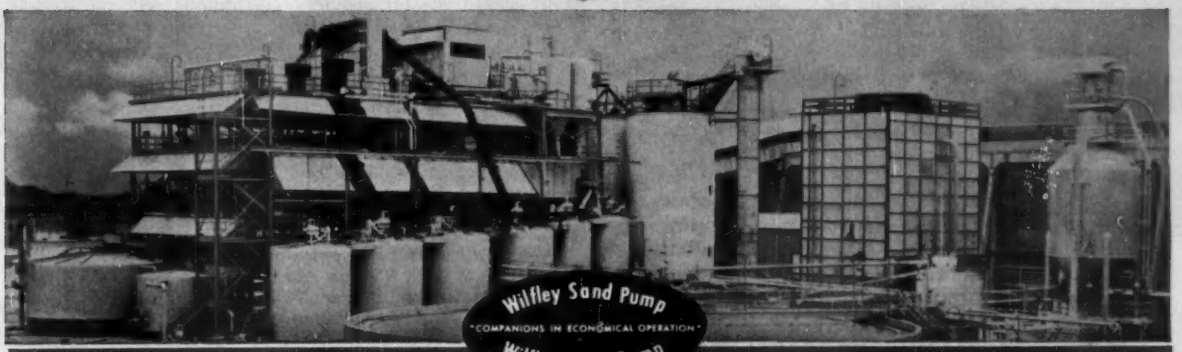
Whenever *you* have a pumping job that calls for high quality Acid Pumps with built-in economy, check with Wilfley.

Wilfley Acid Pumps are available with pumping parts of the machinable alloys as well as plastic to meet all requirements.

Write, wire or phone for complete details.

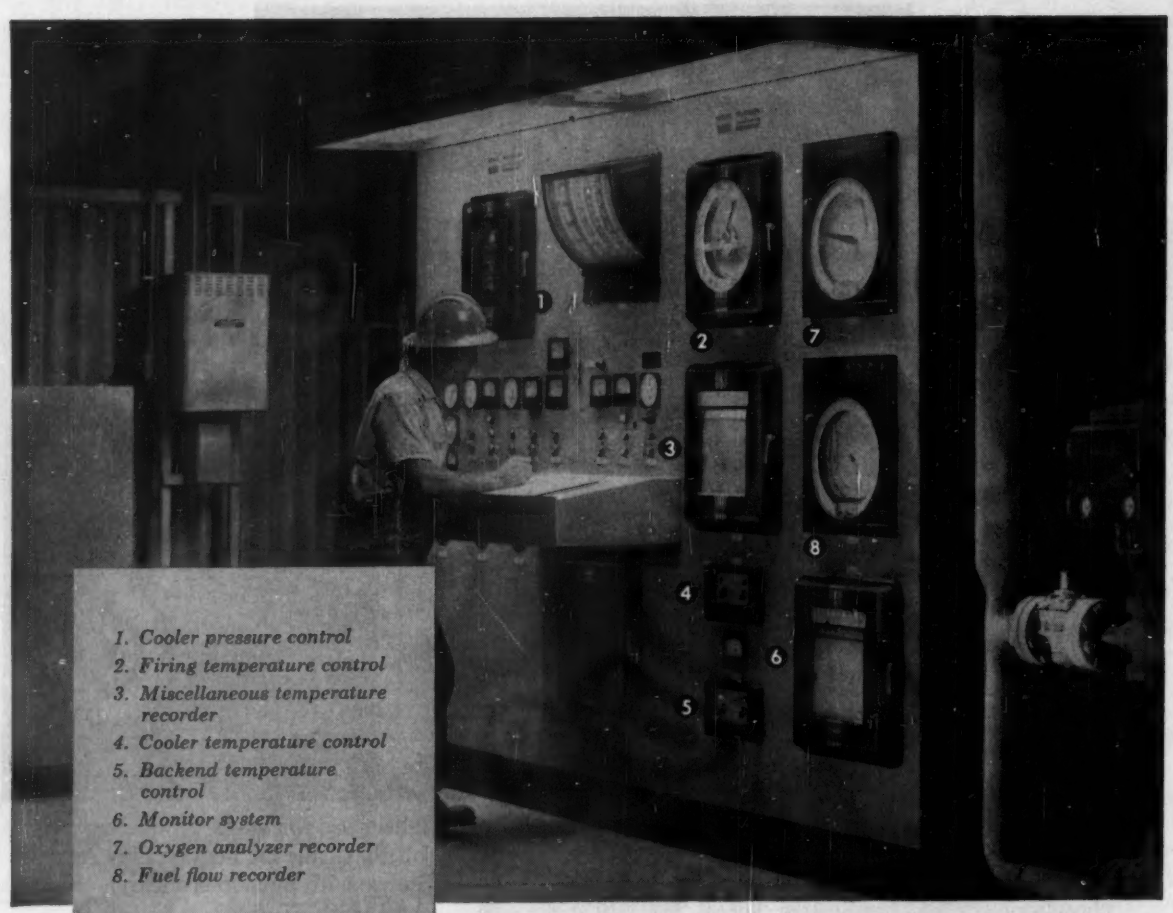
DESIGNED AND ENGINEERED BY DORR-OLIVER INC.

FOR AMERICAN CYNAMID COMPANY



A. R. WILFLEY and SONS, INC.

DENVER, COLORADO, U.S.A. • NEW YORK OFFICE: 122 EAST 42nd ST., NEW YORK CITY 17



1. *Cooler pressure control*
2. *Firing temperature control*
3. *Miscellaneous temperature recorder*
4. *Cooler temperature control*
5. *Backend temperature control*
6. *Monitor system*
7. *Oxygen analyzer recorder*
8. *Fuel flow recorder*

Here's kiln control that works

Now, at the Baton Rouge plant of the Ideal Cement Company, this complete *system engineered* instrument and control cubicle is on 'round-the-clock duty.

Designed and built by L&N specialists, this control system applies modern concepts of instrumentation and standardized production techniques to Ideal's wet process kiln.

Here are some of the highlights of Ideal's instrument and control system that can benefit *your* plants.

1. Cooler pressure—Cooler draft automatically is held constant by L&N pressure controller.

2. Firing temperature — Control of clinker firing temperature is achieved with Speedomax® G recorder-controller from Rayotube® detector sighting *directly* on moving product.

3. Miscellaneous temperatures — Temperatures at 5 separate points within the kiln system are clearly charted by fast-acting Speedomax G.

4. Cooler temperature — Combustion air temperature is automatically stabilized by 3-action electric control and Speedomax G.

5. Backend temperature — Automatic temperature regulation is assured by 3-action electric control and Speedomax G.

6. Monitor system—Unique L&N *system engineered* design provides continuous records of operating performance of 10 important variables in the system.

Oxygen analyzer and fuel flow recorder complete the system.

Planning new kilns? Plant modernization programs? In a new 16 page illustrated folder, L&N shows you how complete system engineering can be applied to your rotary kiln operation. Call your L&N office or write directly to 4916 Stenton Ave., Phila. 44, Pa. Ask for Folder N-0720(1), "Modern Practices in Rotary Kiln Instrumentation."

LEEDS & NORTHRUP
Instruments — Automatic Controls • Furnaces

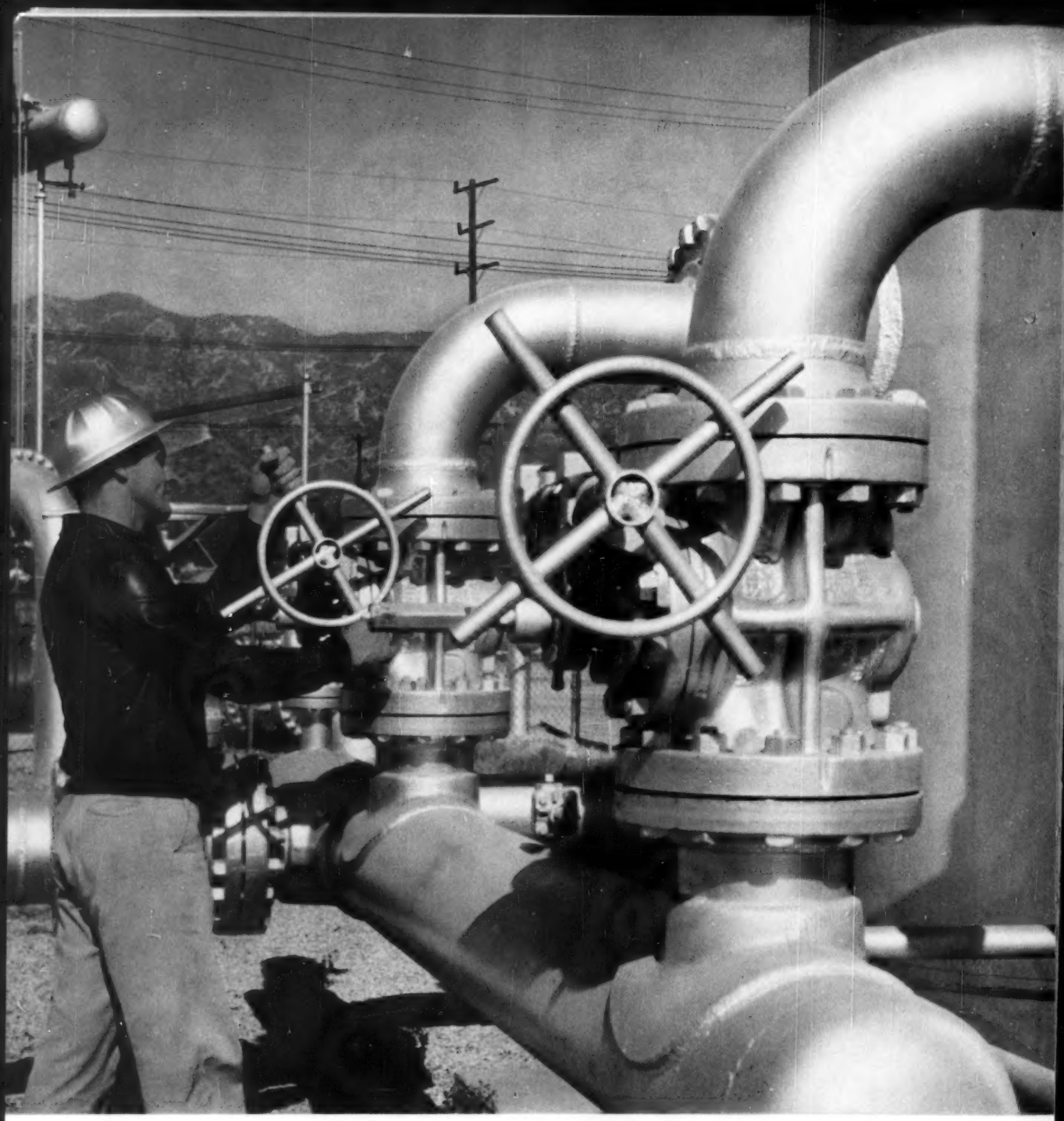
WILL IT WORK? Of course—it's a Rockwell-Nordstrom *lubricated* plug valve. Even after months in an open or closed position, the *lubricated* plug responds instantly for easy, quarter-turn operation. While there can be no compromise with absolute dependability, you pay no more, often less, for the superior reliability of Rockwell-Nordstrom valves.

Whatever your flow control needs, specify Rockwell-Nordstrom . . . the world's most *complete* line of lubricated plug valves. Rockwell Manufacturing Co., Pittsburgh 8, Pa.

ROCKWELL-Nordstrom VALVES

it's **ROCKWELL**

MANUFACTURING COMPANY



HOW TO GET THE "OFF" IN SHUT-OFF

Some valves aren't really off when they're shut because their exposed seats soon wear or cut. Rockwell-Nordstrom valves are sealed by a tough, instantly replaceable film of pressurized lubricant and the seats are never exposed to the line . . . they *stay* leakproof year after year.

Rockwell-Nordstrom is the world's most complete line of lubricated plug valves and plug valve accessories. Rockwell Manufacturing Company, Pittsburgh 8, Pa.

ROCKWELL-Nordstrom VALVES

it's ROCKWELL

MANUFACTURING COMPANY

NEW! FULLY STANDARDIZED EXCHANGER OFFERS UNPRECEDENTED FLEXIBILITY

down go costs and delivery time for the process industries

It's here . . . the most versatile heat exchanger ever developed for the chemical industry — the Ross C-100. Of quality construction throughout, it is pre-engineered and fully standardized, by-passing high costs and delays inherent in custom fabrication.

Readily assembled to handle any combination of liquids and gases, the C-100 can be used as a heater, cooler, condenser or vaporizer for hundreds of process applications.

Extreme flexibility predominates . . . in materials, sizes and arrangement of components, mounting position, tubeside passes, nozzle orientation. Your choice is virtually limitless in meeting a tremendous range of conditions.

Want specific details? New illustrated Bulletin 302.5K1 will bring you all the facts on design, materials, sizes and adaptability. Send the coupon for your copy.

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AMERICAN-Standard
ROSS HEAT EXCHANGER DIVISION

Mail this coupon for new Bulletin

To:
American-Standard*
Ross Heat Exchanger Division
Buffalo 5, N. Y.

Please send your new illustrated Bulletin 302.5K1 fully describing the Ross Type C-100 Heat Exchanger.

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ADDRESS _____

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Kathabar® systems maintain spaces at 80 F and 55% RH, or lower, for processing, storage, and testing!

You can pick the best production weather you've ever had, and reproduce it every day of the year. You can set the exact storage temperatures and humidities which are ideal for your product. And in your testing lab, you can imitate any climate on earth.

All of this you can do economically with a Kathabar-engineered air conditioning system. In many applications, cooling can be accomplished with available water (e.g., a Kathabar system can reduce 72 F dew point air to 46 F dew point with 85 F cooling tower water). Refrigeration, when needed, is free to handle only sensible cooling with minimum tonnage and higher suction temperatures—without frost or duplicate coils. No overcooling or reheating necessary.

let's look at cases

This sampling of Kathabar installations will show you how effective and versatile a Kathabar system can be.

9 climates for candy

Candy's sold seasonally, but manufacturing economy demands uniform production throughout the year. A Chicago company uses Kathabar systems to store different types of candy in 9 separate zones. Humidities range from 12 to 50% RH; temperatures, 50 to 85 F.

zoned for profits

Another candy manufacturer spots individual Kathabar units and cooling units to fit the varied requirements of drying, chilling, polishing, coating, bottoming, packaging, storage, and comfort. One example of Kathabar-earned profits: polishing time cut in half.

ethical competition

In the high-volume, low-margin pharmaceutical industry, companies always seek new ways to reduce costs and improve quality control. One of the biggest companies achieves both with Kathabar systems in over 100 air conditioning zones. Outside weather can not interrupt processes. As a bonus, Kathabar systems deliver sterile air.

getting jets off the ground

The chemicals in solid rocket fuels are extremely hygroscopic, and must be dried before use. Kathabar systems protect their physical properties and insure accurate ballistic results. Process areas are maintained at precise conditions, even when hosed down frequently.

relieving printers' headaches

Kathabar systems keep printing papers from getting too wet or too dry; improve ink distribution and drying; eliminate the variables in plate-making. Printers earn new profits with more press time, fewer schedule upsets.

fast compressor assembly

Water vapor in a refrigerator compressor could cause obvious troubles. A Kathabar system enabled a large manufacturer to switch from batch to continuous drying—and cut production time, handling, and manpower.

who uses Kathabar systems

Kathabar systems make profits out of air for these industries:

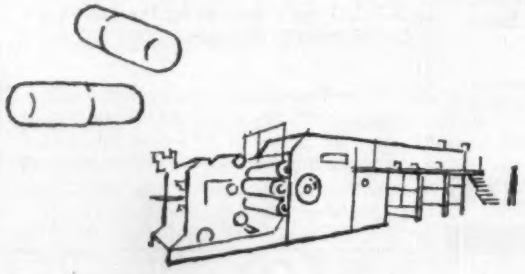
Atomic Energy	Machining
Breweries	Matches
Cake Mix	Marine
Candy	Meat
Cellophane	Offices
Cellulose	Ordnance
Cereals	Paper
Chemicals	Pharmaceuticals
Coffee	Plastics
Comfort	Printing
Compressors	Rockets
Cookies	Rubber
Electronics	Shellac
Explosives	Sugar
Film	Sanitaryware
Foundries	Testing
Gelatin	Textiles
Glass	Transformers
Glue	Transistors
Gum	Vacuum Tubes
Hospitals	Varnish
Hotels	Waterworks
Lacquer	Wire
Lenses	Yeast

how they use Kathabar systems

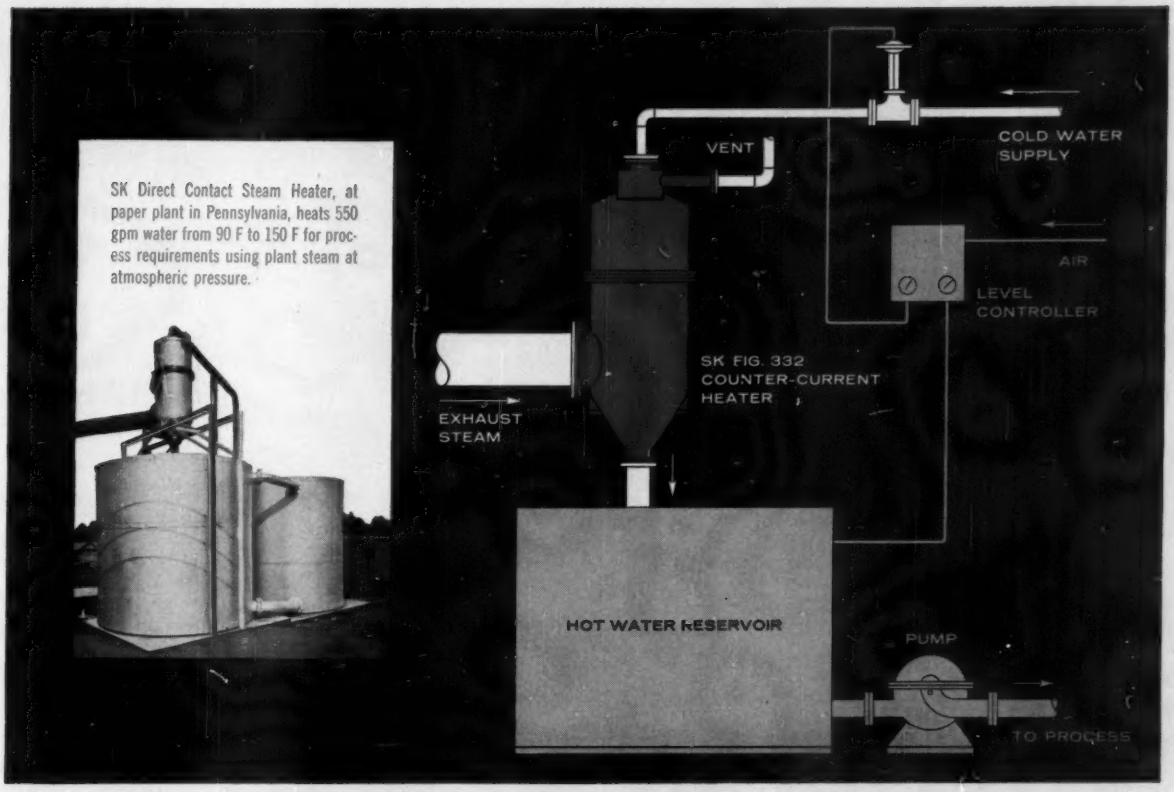
Many of these industries use Kathabar systems to maintain spaces at 80 F and 55% RH or lower. Others use them to (1) obtain continuous air at sub-freezing dry bulb and dew points; (2) eliminate condensation; (3) maintain spaces at specific low bacteria or mold count; and (4) improve drying processes.

send description of your problem

Air Conditioning and Drying Division
SURFACE COMBUSTION CORPORATION
2380 Dorr Street Toledo 1, Ohio



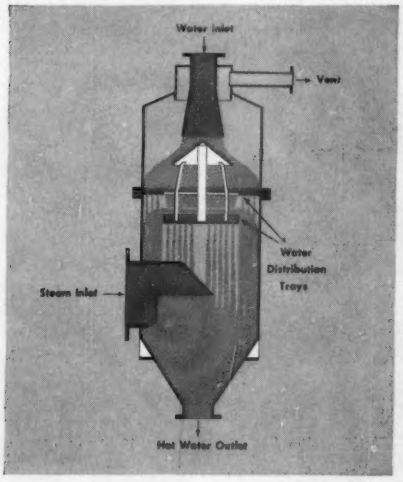
Kathabar systems by Surface


SK Direct Contact Steam Heater, at paper plant in Pennsylvania, heats 550 gpm water from 90 F to 150 F for process requirements using plant steam at atmospheric pressure.
VENT
COLD WATER SUPPLY
AIR
LEVEL CONTROLLER
SK FIG. 332 COUNTER-CURRENT HEATER
EXHAUST STEAM
HOT WATER RESERVOIR
PUMP
TO PROCESS

FOR HOT WATER IN LARGE QUANTITIES

use SK Direct Contact Steam Heaters

Sectional drawing of SK Fig. 332
Direct Contact, High Capacity, Steam Heater



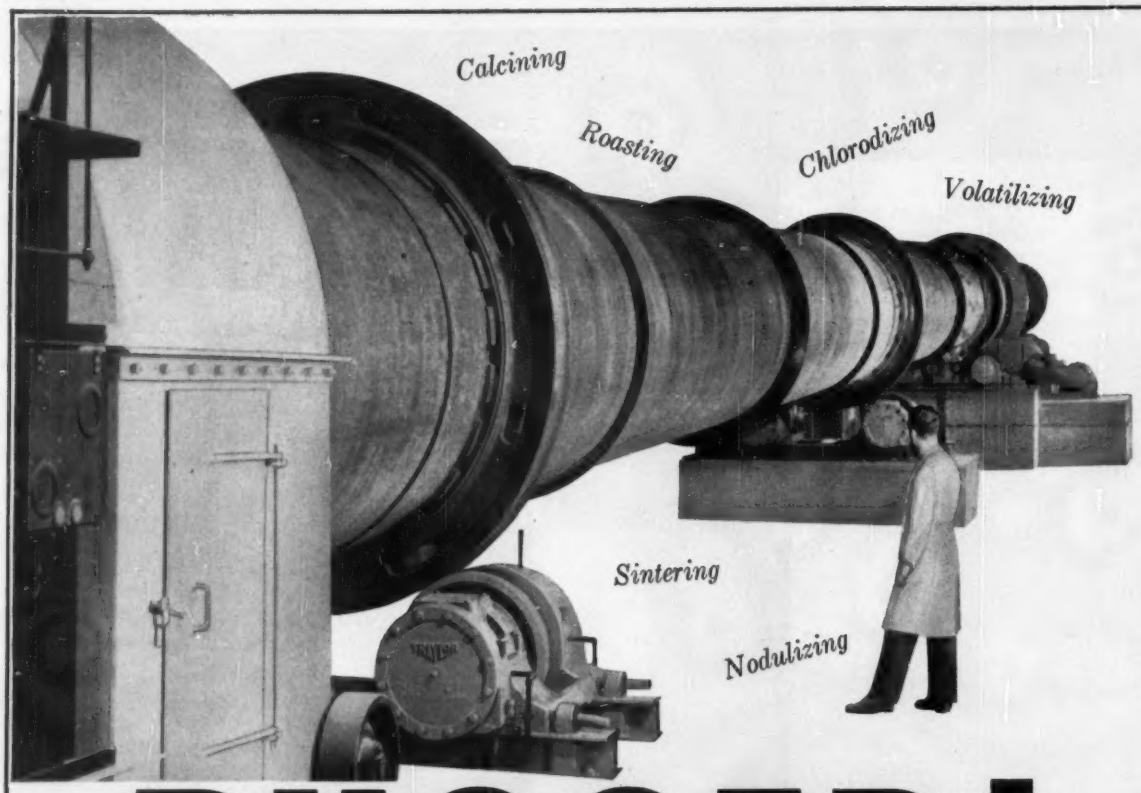
SK Direct Contact Steam Heaters are designed to provide large quantities of hot water, or other liquid, for plant or process use. They do this by using plant exhaust steam (at low pressure or at vacuum to 15 in. Hg) to heat the water which is then delivered to a tank or reservoir.

To users, these high capacity heaters offer specific, worthwhile advantages. They are simple in design, have no moving parts. Heating, by condensation of steam in the liquid, is very efficient, continuous, and fast. A temperature rise of 130 F is possible with most of these units. Semi-solids in the liquid are handled without difficulty. Costs are reasonable and the heaters require little maintenance. Capacity can be just about any reasonable amount desired, since capacity is determined by heater size and SK has not established any maximum. Although cast iron and fabricated steel are standard materials of construction, other special materials can be used when required.

The counter-current unit pictured above and at left is one of four types made by SK. This particular heater and all of the other types are described in detail in Bulletin 3A-HC which includes application information and data on sizes, dimensions, and capacities. Copies of Bulletin 3A-HC are available immediately on request. Send for a copy.

JET APPARATUS: Ask for Condensed Bulletin J-1.
ROTAMETERS & FLOW INDICATORS: Ask for Condensed Bulletin M-1.
VALVES: Ask for Condensed Bulletin V-1.
HEAT TRANSFER APPARATUS: Ask for Condensed Bulletin HT-1.
GEAR PUMPS: Ask for Bulletin 17-A.

Schutte and Koerting
COMPANY
MANUFACTURING ENGINEERS SINCE 1876
2217 State Road, Cornwells Heights, Bucks County, Pa.



RUGGED!

Traylor MADE

ROTARY KILNS, COOLERS, DRYERS

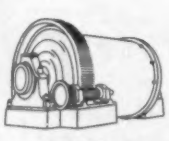
Throughout the process industries, Traylor Rotary Kilns are regarded as the finest thermo-processing equipment available for calcining, roasting, chlorodizing, volatilizing, sintering, and nodulizing. This universal regard has been earned by the great efficiency and rugged endurance built into them. Heavy steel plate shells are automatically welded together, full floating riding rings are turned true and smoothly faced.

TRAYLOR COOLERS AND DRYERS have the same basic construction features as the kiln . . . all Traylor-made to fit the job.

TRAYLOR ENGINEERING & MFG. CO.

1080 MILL ST., ALLENTOWN, PA.

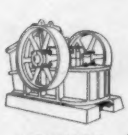
Sales Offices: New York — Chicago — San Francisco
Canadian Mfr.: Canadian Vickers, Ltd., Montreal, P.Q.


BALL MILLS

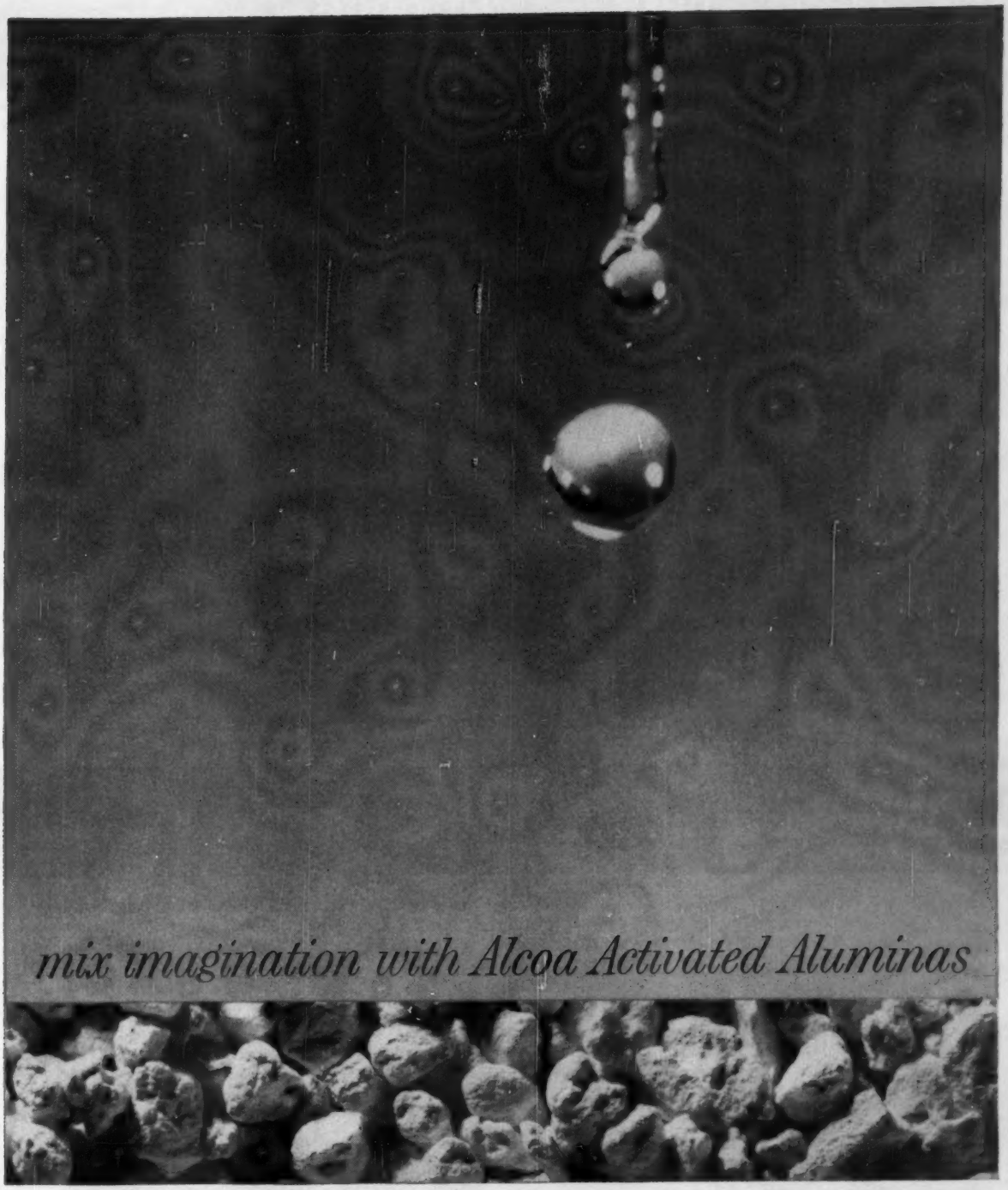
ROTARY KILNS

APRON FEEDERS

PRIMARY GYRATORY CRUSHERS


JAW CRUSHERS

SECONDARY GYRATORY CRUSHERS



to remove the last drop of unwanted product or process water. Is unwanted water undermining your product quality . . . or ruining the efficiency of your process? If so, try this sure solution to your dehydration problems: mix imagination and engineering with Alcoa® Activated Alumina. You can count on this old reliable among commercial desiccants to achieve the lowest dew points you require. It can never soften, swell or disintegrate. It is nontoxic, noncorrosive and practically iron-free. It can be saturated and reactivated through almost endless cycles—to keep drying costs low. Put the proved effectiveness of Alcoa Activated Alumina to work in solving *your* dehydration problems. Drying machines charged with Alcoa Activated Aluminas are available from a number of manufacturers. For their names, or for product information, contact your local Alcoa sales office. Or write ALUMINUM COMPANY OF AMERICA, CHEMICALS DIVISION, 702-H Alcoa Building, Pittsburgh 19, Pa.

ALCOA CHEMICALS
ALUMINUM COMPANY OF AMERICA

"ALCOA THEATRE"
Exciting Adventure
ALTERNATE MONDAY EVENINGS

For finer products . . . let Alcoa add new dimension to your creative thinking!

Need COOLER RUNNING MOTORS for your big jobs?

In Ratings thru 500 hp Standard TEFC or Explosion-Proof

WAGNER Tube Ventilated Motors can solve your problem

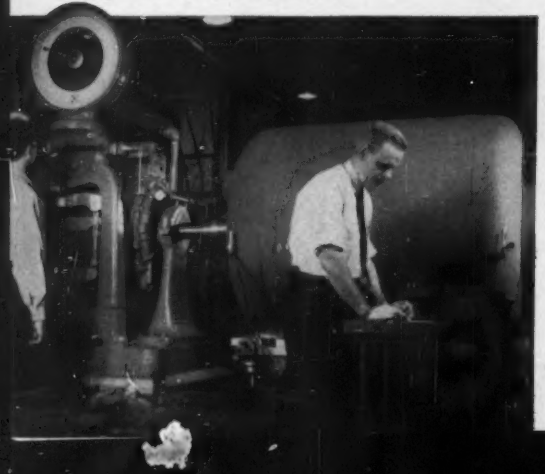
For big fans, blowers, pump drives—heavy duty applications where you need large motors with highly effective cooling systems for long life—choose Wagner Tube Ventilated Motors.

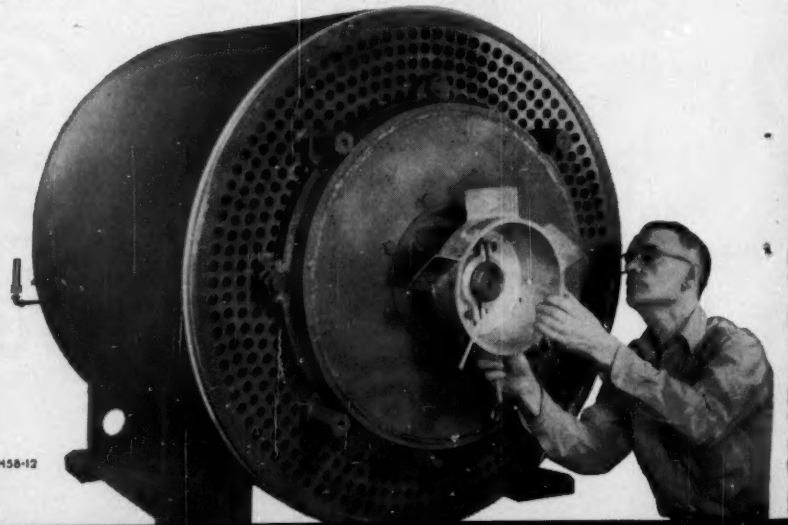
These motors have fabricated steel frames that are provided with a series of tubes through which cooling air is forced by an external blower. Internal blowers, one at each end of the rotor, circulate the warm air inside the motor through ducts in the rotor and stator and around the cooling tubes. This effective cooling system holds the operating temperature of the motor within the specified limits of 55° C Rise for Class A or 75° C for Class B insulated motors.

Wagner tube ventilated motors are available as Type YP, standard TEFC, with Class A or Class B insulation; or as Type ZP, explosion-proof, with Class A insulation only. Type ZP motors can be supplied with Underwriters' Labels for Class I, Group C or D, or for Class II, Group E, F or G locations. Let your Wagner Sales Engineer show you how these motors can solve your big motor problems.

WAGNER ELECTRIC CORPORATION • 6407 Plymouth Ave., St. Louis 14, Mo.

This 400 hp tube ventilated motor is being tested on a 1000 hp dynamometer at the Wagner plant. Photo of motor at right, with blower shield removed, shows cooling tubes and external blower.





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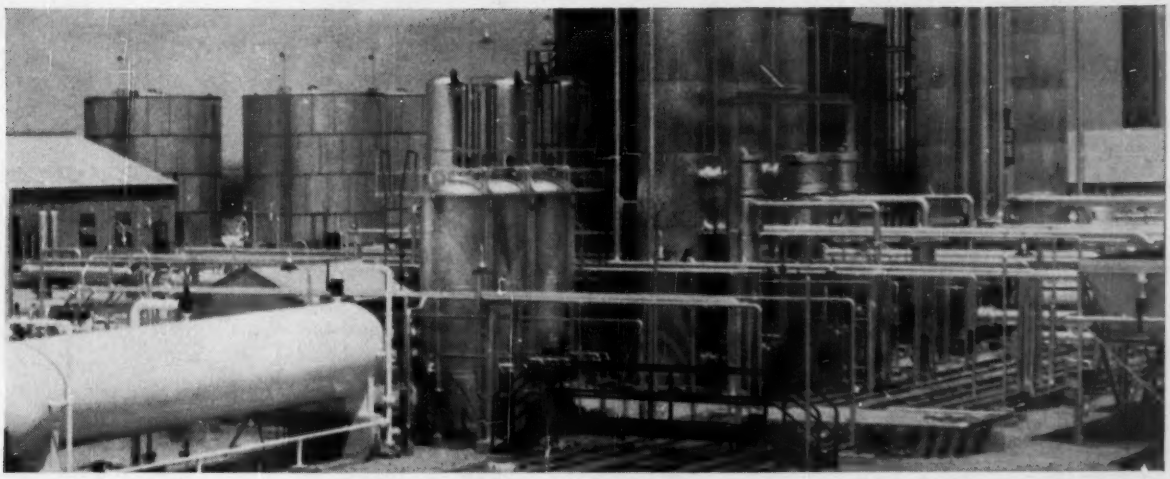


Aluminum Process Pipe is the most economical corrosion-resistant pipe available

Lower First Cost—Aluminum pipe costs much less than any comparable corrosion-resistant pipe. Stainless steel piping, for example, costs from 4 to 10 times more than aluminum; monel costs 6 times more; nickel costs 5 to 7 times more than comparable aluminum piping.

Lower Installation Cost—Installation costs can be lower with Reynolds Process Pipe because it is lighter, easier to form and handle. It welds rapidly and easily, and a full range of flanges and fittings is available.

Lower Maintenance Cost—There is practically no maintenance with Reynolds Aluminum Process Pipe. It resists most corrosive atmospheres, retains its attractive appearance throughout its long life.

Corrosion Resistance—Reynolds Aluminum Pipe won't contaminate or discolor fluids it handles, as other piping does. It remains passive, and will handle without corroding such fluids as hydrogen peroxide, nitrogen solutions, alcohols, foods, organic acids (except those containing chlorides), sulphur, glycerine, sweet and sour crudes, raw or refined gases, oxygen, many acids and other hard-to-handle process liquids.

Low Temperature Work—As working temperatures drop, aluminum pipe improves in tensile and yield strength, and keeps its ductility and resistance to shock loading. Reynolds Aluminum Pipe has been used at −320°F. In addition, this pipe has high thermal conductivity, and is non-sparking.

For detailed information on the properties and specifications of Reynolds Aluminum Process Pipe, call your local Reynolds office, or write *Reynolds Metals Company, P.O. Box 2346-CJ, Richmond 18, Virginia.*

Write for this important literature: "Corrosion Keys for Aluminum" and "Aluminum Process Pipe."

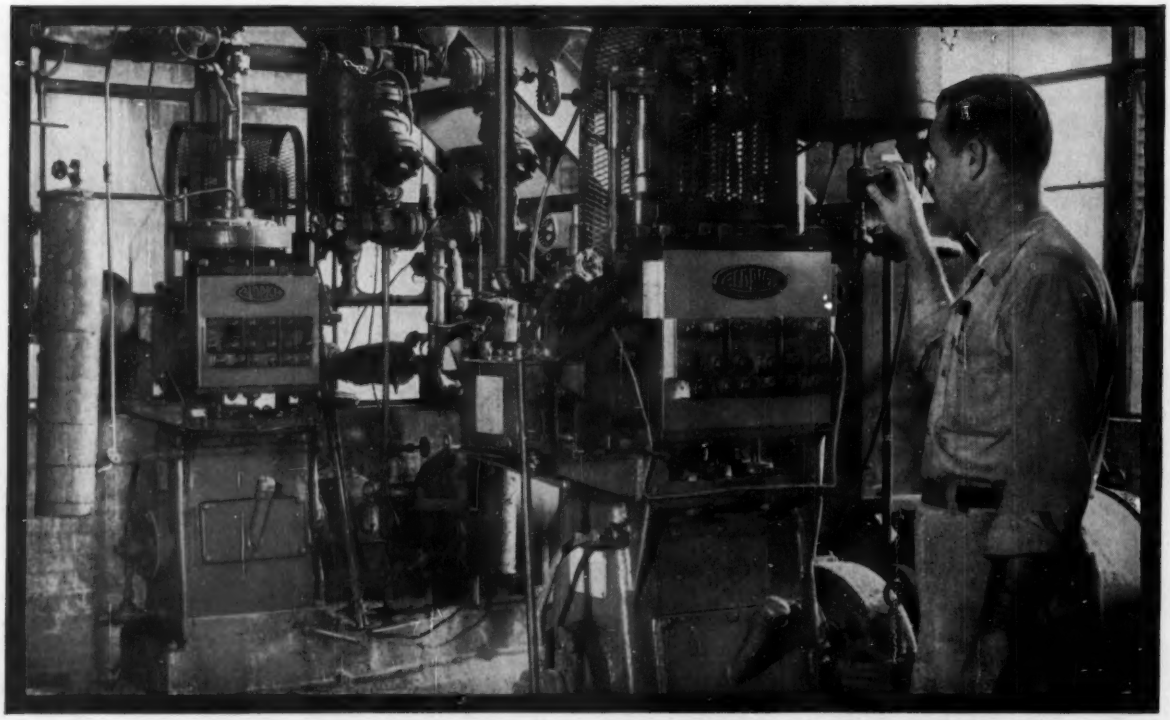
Watch Reynolds All-Family Television Program, "DISNEYLAND", ABC-TV.

REYNOLDS ALUMINUM

EMERY INDUSTRIES LICKS TOUGH PROBLEM:

How to pump fatty acids 24 hours a day, 7 days a week, and cut maintenance costs!

Around-the-clock hydrolysis produces fatty acids from animal fats, tallow, palm, soybean, cottonseed and corn oils at Emery Industries plant in Cincinnati, Ohio. Pumps work on hot corrosive fatty materials 24 hours a day, seven days a week, and maintenance used to be a costly problem. Packings had to be replaced far too often. Valves needed frequent refacing. Wear of plungers was excessive.



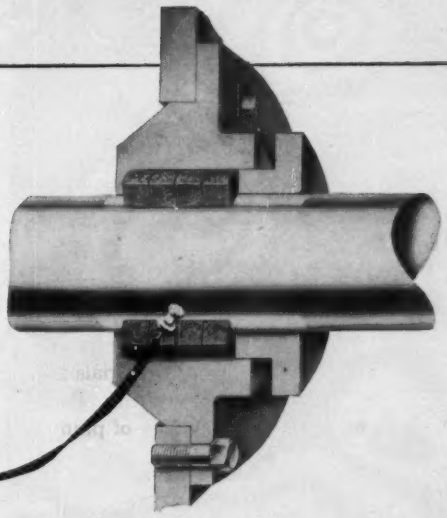
How Emery solved the puzzle: Looking for an answer to the problem of excessive downtime and maintenance, Emery conferred with several pump manufacturers. Aldrich was the only company to offer a pump better in both design and materials . . . the fluid end being of stainless steel. Original, ineffective pumps were immediately replaced with Aldrich Triplex Pumps.

Result: Two Aldrich Pumps have pumped raw materials on a continuous basis since 1948. Two more were installed for additional capacity in 1954. Maintenance costs have been reduced substantially. Downtime has decreased to a minimum. Operating efficiency is now at an all-time high and quality of processing has improved. We'll be glad to send you full information on Aldrich Pumps and their advantages to you. Simply write Aldrich Pump Company, 3 Gordon Street, Allentown, Pa.

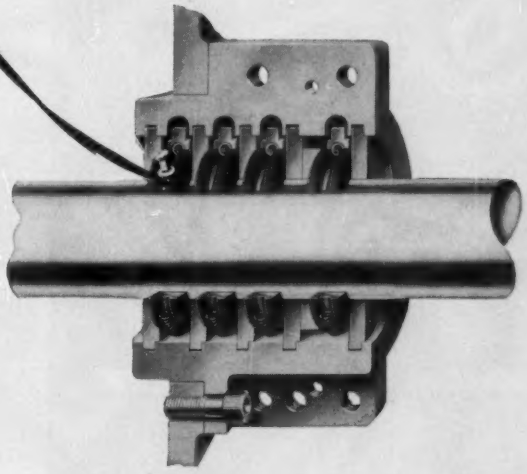
the toughest pumping problems go to ALDRICH

COPPUS TURBINES

offer you a choice of packing rings



STANDARD METALLIC RING PACKING — Made of high grade asbestos cores encased in specially treated lubricated aluminum foil. Recommended as a low-friction, long-service packing for steam temperatures up to 850 F and back pressures up to 50 lb. Adjustable packing glands keep leakage at minimum. Easy access to packing rings.



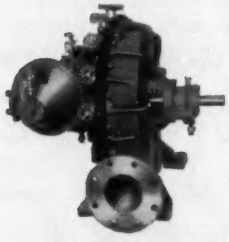
OPTIONAL CARBON RING PACKING — Consists of three carbon packing rings on the pressure side and one beyond the leak-off section. Each ring has three segments held together by a stainless steel garter spring. For back pressures up to 75 lb. Standard for vacuum or gas operation, or when leak-off is desired.

Heavy chrome plating on shaft at stuffing box is common to both types of Coppus packing.

Coppus Turbines ranging from 150 hp down to fractional in 6 frame sizes

FIT TURBINE COSTS TO HORSEPOWER NEEDS

When you buy turbines rated close to your exact horsepower needs, you save plenty of money. That's because turbines are generally priced in proportion to their size. The wide range of sizes of Coppus Turbines promises purchasing economy for you from the 150 hp size down to the smallest. As for operating and maintenance economies, you get them, too, from such other features as: greater number of manually operated valves for individual control of steam nozzles; replaceable cartridge-type bearing housings and others. For complete details . . .



WRITE FOR BULLETIN 135
COPPUS ENGINEERING CORPORATION
229 Park Avenue
Worcester 2, Mass.
Sales offices in THOMAS' REGISTER

COPPUS "BLUE RIBBON" TURBINES

Recording Unit for Variable 1
Recording Unit for Variable 2
Controlling Unit for Variable 1
Controlling Unit for Variable 2
Units added to Recorder-Controller as needed

Bailey Recorder is key to "step-by-step" automation

When you are pioneering a new process and don't know all the answers, complete automation is seldom practical. The first step is to identify your variables and measure them. Nothing does this job better than a Bailey Recorder. One instrument can record any four variables that can be converted to electric *or* pneumatic signals.

Once you get a better understanding of the variables in your process, you will want to add controls and feed back your measurements. Here's where the versatility of the Bailey Recorder comes into play. For the same Bailey instrument you use to record variables is designed to accommodate plug-in control units.

When you use a Bailey Recorder, you can build your instrumentation along with your process. At the start, you use only the plug-in units for recording. Then you add plug-in controls as you see the need for them.

For the complete story of how you can use a Bailey Recorder for step-by-step automation, see your Bailey Engineer. G-42-1

Instruments and controls for power and process

BAILEY METER COMPANY

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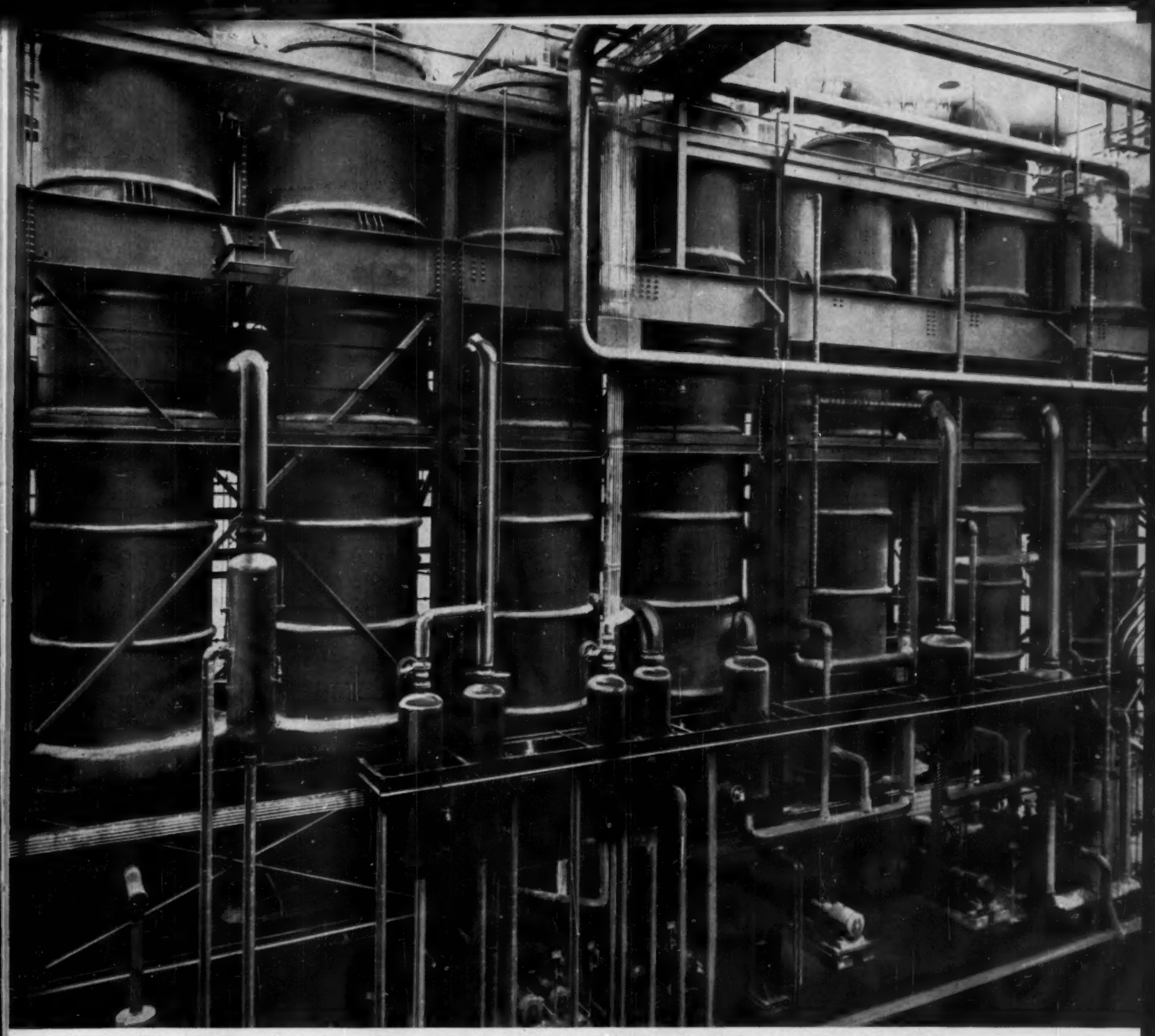
In Canada—Bailey Meter Company Limited, Montreal

BAILEY METERS



Paper mill handles waste liquor from 400 tons of pulp per day in a Buflovak Septuple Effect Evaporator. With a total heating surface of 66,500 square feet, this especially designed unit evaporates 6.3 pounds of water per pound of steam.

Longview Fibre Company cuts steam needs with unique Buflovak Evaporator

Saved: 2,500 pounds of steam per hour in concentrating waste black liquor. In designing and building this giant, septuple effect evaporator, Buflovak engineers used three vapor heat exchangers to lower steam requirements . . . boost operating efficiency.

Waste solids produced by the Buflovak evaporator can be eliminated profitably. Instead of creating a difficult disposal problem these wastes are burned as an auxiliary boiler fuel.

Processing economies like these are typical of Buflovak job-engineered evaporators. Because Buflovak builds a full evaporator line, you are sure of an impartial recommendation based exclusively on your needs.

Pre-test your evaporating process in Buflovak's Customer Service Laboratory

This fully equipped research center contains both small scale and pilot size testing equipment. Whether you examine a beaker of material or make a full scale production run, you'll get dependable results, accurate data . . .

Write for Catalog 372 on evaporators. Catalog 381 on the lab. Also refer to C. E. Catalog, pages 429 to 452.

BLAW-KNOX

BLAW-KNOX COMPANY
Buflovak Equipment Division
1551 Fillmore Avenue, Buffalo 11, New York

News from
National Carbon Company
Division of Union Carbide Corporation • 30 East 42nd Street, New York 17, N. Y.
Sales Offices: Atlanta, Chicago, Dallas, Kansas City, Los Angeles, New York, Pittsburgh, San Francisco. IN CANADA: Union Carbide Canada Limited, Toronto

National Carbon representatives expand your engineering force

H. L. SHEPARD—SALES ENGINEER

Mr. Shepard graduated from Iowa State College with a B.S. in chemical engineering. He has been with National Carbon Company for 25 years. Prior to this he was a chemist and chemical engineer in process control with a non-ferrous producer and in industrial water treatment operations.

Shepard is a former manager of National Carbon's Specialties Department, a forerunner of today's Chemical Products Marketing Department. He has been a sales engineer in the Midwest and the Southwest, and presently is covering the mid-Atlantic area. Here he aids in the selection, special designing, and installation of carbon, graphite and "Karbate" chemical process equipment.

Call your National Carbon Sales Engineer today . . . he can save you time, money and needless worry.

"National" Carbon Brick available in eleven styles of 9" x 4½" x 2½" size series

Carbon's chemical inertness plus unique physical properties make these brick an excellent choice for lining tanks, drain troughs and sumps handling corrosives. Carbon brick are widely used for applications involving hydrofluoric acid, nitric-hydrofluoric acid mixtures, caustic soda, phosphoric acid, and sulphuric acid – hydrocarbon mixtures. Circle brick can be supplied on request. **Catalog Section S-6215.**

VERSATILE CARBON AND GRAPHITE STRUCTURES CUT COSTS IN HIGH TEMPERATURE CORROSIVE PROCESSES

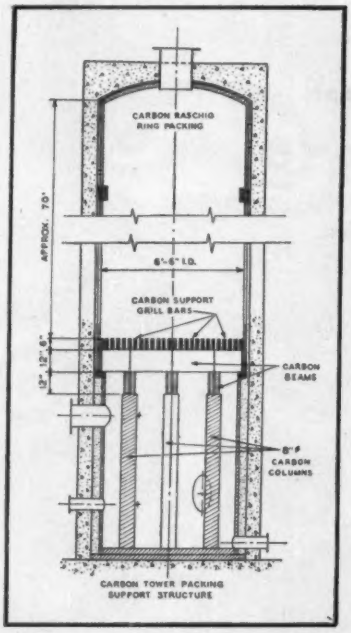
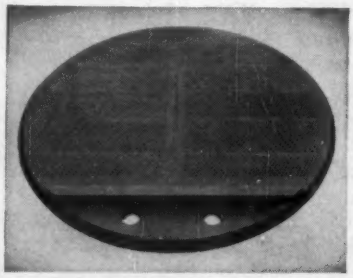


Diagram of a typical carbon tower packing support structure.



Graphite sieve tray 9' 10" in diameter and 3" thick contains 5612-½" diameter holes.

Carbon and graphite are proving economical when used for high temperature chemical processing equipment such as combustion chambers, reactor vessel linings, bubble cap trays, sieve trays and packing support structures. At elevated temperatures, these materials provide almost universal corrosion resistance and structural stability. These properties are maintained at temperatures up to 4000°F in reducing atmospheres. Furthermore, high thermal conductivity enables water-cooled graphite structures to withstand up to 2000°F under oxidizing conditions.

Easily machined to close tolerances, graphite can be worked even with hand tools. Depending on size and processing requirements, the materials can be supplied for either monolithic or segmental structures. Segmental structures have been built with walls 20' long x 15' high, using blocks 7½" thick, 28" wide and 72" long.

Graphite plate-type tower packing support installed in a primary phenol stripping column. Here the slotted cap design increases the free area.

NATIONAL TRADE-MARK

The terms "National", "N" and Shield Device, "Karbate" and "Union Carbide" are registered trade-marks of Union Carbide Corporation.

UNION CARBIDE

Power Plant Ducts and Casings of Armco ALUMINIZED STEEL Cost Less, Last Longer

Power plant installations have demonstrated that Armco's special hot-dip aluminum-coated steel offers opportunities to improve performance and cut costs of boiler casings, ducts and similar units.

Armco ALUMINIZED STEEL Type 2 cuts costs because it:

—eliminates the need for painting.
—costs less than other metals with comparable properties.
—reduces maintenance expense.

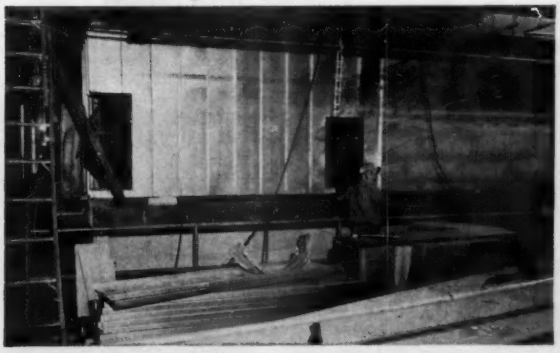
Armco ALUMINIZED STEEL Type 2 improves performance because it:

—provides high strength and rigidity.
—has high heat reflectivity that reduces heat loss.
—resists atmospheric corrosion.

Wide Application

ALUMINIZED STEEL is also giving economical and satisfactory service in applications such as stack and reactor shields and insulation jacketing for piping and processing units.

Put the multiple advantages of this special aluminum-coated Armco Steel to work in *your* equipment. For complete information on ALUMINIZED STEEL Type 2 and its companion grade (Type 1), used for resistance to a combination of heat and corrosion, just fill out and mail the coupon.



New steels are born at Armco

ARMCO STEEL CORPORATION, 2698 Curtis St., Middletown, Ohio

Send me information on Armco ALUMINIZED STEEL

We are considering it for_____

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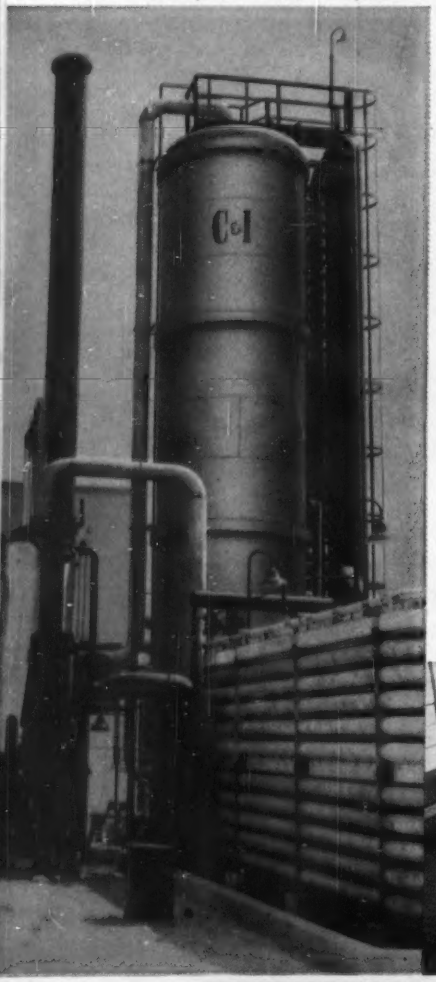
ARMCO STEEL

Armco Division • Sheffield Division • The National Supply Company • Armco Drainage & Metal Products, Inc. • The Armco International Corporation • Union Wire Rope Corporation • Southwest Steel Products

america's first self-sustaining nitric acid plant

Atlas Powder Company's new 250 ton-per-day self-sustaining nitric acid plant located at Joplin, Mo.



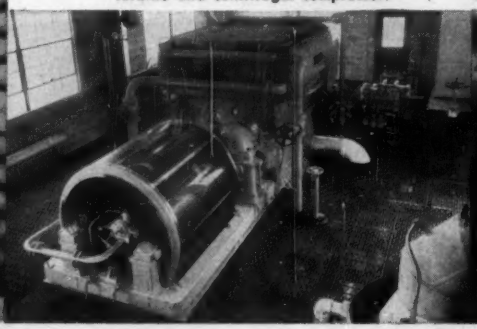
Recently completed for Atlas Powder Company, this new nitric acid plant is now producing 250 tons-per-day at the lowest cost in history. After start-up, C & I's revolutionary design produces enough steam coupled with the energy from the exhaust gases to run the entire plant without any outside source of power.

Here's what the Atlas people have to say about this new C & I installation. "This plant was started up on May 6, 1958, and during this first test run it operated as designed from a standpoint of capacity and self-sufficiency with indications of an excess of steam."

Newest of the many C & I-built nitric acid plants giving guaranteed performance throughout the world, the Atlas installation is unique in its super efficiency. If you are considering nitric acid or expanding your present facilities, it will pay you to consult C & I for only C & I has the know-how and experience to build money-saving, self-sustaining plants of this type.

Send for complete information and descriptive literature, today.

A portion of the compressor room showing the Brown-Boveri expander turbine and centrifugal compressor.



Primary drive for the compressor—G E steam turbine.

designed and constructed by C&I®

THE CHEMICAL AND INDUSTRIAL CORP.

CINCINNATI 26, OHIO

nitric acid • phosphoric acid • ammonium nitrate • complex fertilizer • ammonium phosphate

No Repairs in a Full Year of Round-the-Clock Service

In the chlorinated products division of Diamond Alkali Company at Painesville, Ohio, these LaBour Type G pumps—purchased in 1948—are on continuous duty, lifting chlorinated solutions to the cooling towers above the mixing tanks. Each of the four pumps lifts about 120,000 gallons per day, to dissipate heat produced by introduction of the chlorine into the process of manufacturing chlorowax, carbon tetrachloride and anhydrous hydrochloric acid. Ten other LaBour pumps serve other divisions of the Painesville plant.

In 24-hour service atop the 15,000-gallon mixing tanks, the LaBour pumps take a beating, but they deliver the work they were bought to do. Sometimes a full year goes by without the necessity for any repairs or replacement parts. LaBour Type G is packingless, so there is never any need for servicing to prevent packing leaks.

If you are looking for this kind of dependable, low-cost service in your liquid moving operations, get in touch with LaBour.

ORIGINAL MANUFACTURERS OF THE SELF-PRIMING CENTRIFUGAL PUMP

LABOUR

THE LABOUR COMPANY, INC. • Elkhart, Indiana, U.S.A.

These cottage cheese tanks have stainless steel linings. Their mild steel exteriors are protected by Tygon ATD Hot Spray Paint.

with

TYGON

PROTECTIVE COATINGS

Operating conditions in high moisture areas, such as are prevalent in many food and chemical processing plants, can cause premature failure of ordinary paint films, and subsequent damage to expensive equipment. Units designed for applications where the equipment receives frequent scrubbing, exposure to water, steam or high humidity need *special* protection if they are to give the trouble-free service customers expect.

That's why more machinery and equipment manufacturers are painting their products with Tygon, using the economical and effective two-step Tygon system described at the right to assure longer-lasting protection against moisture, as well as chemical fumes, acid spillage and other highly corrosive agents.

STEP 1 **APPLY TYGORUST PRIMER**

The effective penetrating action of this unique primer provides excellent adhesion to dry or damp rusted steel. No sandblasting or costly surface preparation needed. Saves time and money. Easily applied by brush or spray. Dries dust-free in minutes—ready for recoating within an hour.

STEP 2 **TOPCOAT WITH TYGON PAINT**

Tygon is available for brush, cold spray, or hot spray application. Tygon Hot Spray is an ideal original equipment coating. It is easy to apply, dries exceptionally fast. Its greatly reduced overspray simplifies masking, saves time and materials. Because no thinners are used, a thicker, denser film is deposited (5 mils or more in just two passes of the gun), with fewer top coats needed. Excellent build-up on sharp edges and other hard-to-protect spots.

Get the full Tygon story. Write today for this Tygon Painting Manual containing complete application and performance data.

PLASTICS AND SYNTHETICS DIVISION

U. S. STONEWARE

AKRON 9, OHIO

228F-1

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DEVELOPMENTS . . .

AUGUST 25, 1958

Chementator

C. H. CHILTON

In situ underground leaching of uranium ore is on trial in New Mexico by American Milling Corp. Leaching reagents (e.g., ammonium chloride and hydrogen peroxide) are injected into ore formation through perforated drill pipe. Results so far are spotty.

Stauffer's concern with Ta-Nb is underscored by new $300,000 semiworks at Richmond, Calif., for making Ta, Nb pentachlorides. Company already has a process for disproportionation of metal chlorides to metals and owns a half-interest in the Temescal electron-beam melting-furnace development.

Fluor is designing a fluid-bed evaporator - calciner for disposal of radioactive wastes from test reactors at Arco, Idaho. Liquid will be sprayed into hot (500 C.) calciner; resulting solid particles, after calcination, will be air-conveyed to dead storage.

Court limits engineer's practice

Judge Christensen's final decree in the Monsanto-Miller case—handed down in Salt Lake City District Court late last month—rings down the curtain on Act I of this poignant drama. (Setting for Act II shifts to Pocatello, Idaho, where Monsanto will tangle with Miller's present employer, Central Farmers Fertilizer Co.)

The decree implements the court's earlier findings (*Chementator*, June 2, p. 43) by enjoining former Monsanto employee Charles M. Miller "permanently and perpetually" from using any Monsanto trade secret "in connection with the design, construction, alteration, modification or operation" of elemental phosphorus furnaces. This injunction applies not only to trade secrets specifically identified as such during the trial but also to any other trade secrets not so identified.

The court virtually bars Miller from future engineering practice in the field of phosphorus manufacture. He is enjoined forever from using confidential Monsanto information as the basis for exercise of engineering judgment in the design, engineering or construction of an elemental phosphorus plant or any part thereof. This restriction applies even to evaluation of designs or data independently conceived or presented to him by a client or employer.

Central Farmers, in an apparent attempt to divorce Miller from direct responsibility for phosphorus manufacture, has named him to the newly created position of "materials manager" for the company. He will direct the company's mining, phosphate rock processing and finished product shipping activities. Even in this job he will undoubtedly have to walk a tightrope to comply with Judge Christensen's ruling.

Another change attributable to the court's findings: CFFC has engaged H. K. Ferguson Co. to finish engineering the Georgetown, Idaho, phosphorus plant, in place of F. C.

(Continued on page 53)

Experience**—the added alloy in **A-L Stainless, Electrical and Tool Steels

Allegheny Ludlum knows more about stainless than anybody . . . and puts it in print for you

Allegheny Ludlum *should* know more about stainless than anybody: they've been the leading producer of all forms for more than 40 years. And the industry's only that old.

Today, A-L produces more different sizes, shapes, finishes and alloys of stainless than any other company. Backing up its quality products are research and development facilities with people second to none.

With know-how and experience gained over the years, Allegheny Ludlum keeps little of it secret: it offers the most complete selection of literature available anywhere.

Literature, designed to help you learn more about Allegheny Stainless and how it can improve your product, is just one help offered by Allegheny Ludlum. You also get the best assistance from trained salesmen and technicians, ready to help you on your specific problem.

All this service is available through your Allegheny sales engineer. Call him today. Or, as a starter, write for the publication list describing the over 150 technical pieces made to assist you.

***Allegheny Ludlum Steel Corporation, Oliver Bldg., Pittsburgh 22, Pa. Address: Dept.** NC-6*

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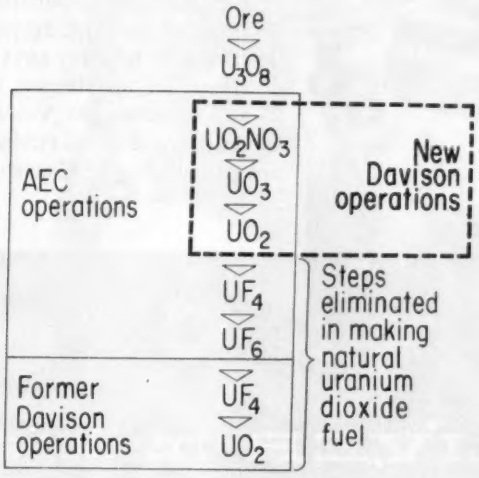
EVERY FORM OF STAINLESS . . . EVERY HELP IN USING IT

Torkelson Co., a codefendant with Miller in the Salt Lake trial. Judge Christensen denied Monsanto's request for an injunction against Torkelson at this time, while granting Monsanto the right to petition for an injunction at any future time.

Now: Shorter route to nuclear fuel



Purchase of uranium concentrate directly from the mill enables W. R. Grace & Co., Davison Chemical Div., to lop off several steps in the private production of nuclear reactor fuels based on natural (unenriched) uranium.

Atomic Energy Commission recently granted Davison permission to buy concentrate directly from Uranium Reduction Co. This is considered a major step in the development of a completely private nuclear power industry.

As shown above, Davison's nuclear fuel plant at Erwin, Tenn.—put into operation earlier this year—previously got all its uranium from Oak Ridge as the hexafluoride. That route will still be followed, of course, to make reactor fuels enriched in U-235; the enrichment process involves gaseous diffusion of UF_6, and AEC retains ownership of all enriched materials.

Can Aussies streamline TiO_2 process?

Latest attempt to continuize the digestion of ilmenite with sulfuric acid has operated successfully on a small scale and will be tried in a now-abuilding pilot plant designed to handle "a few hundredweight a day."

This work is being done in Western Australia by Cable (1956) Ltd., an ilmenite producer. Process is the brainchild of Vladimir Popoff-Asotoff of Perth.

Acid digestion or "attack" of titanium ore, such as ilmenite, is the first step in production of TiO_2 pigment (see Process Flowsheet, *Chem. Eng.*, Jan. 27, 1958, pp. 98-101). It is conventionally carried out batchwise in huge vessels lined with acidproof brick and lead. The same vessels also serve for dissolving the solid reaction mass in water and for converting ferric sulfate to ferrous.

One of the objectives of the continuous process is use of smaller, cheaper equipment. Ilmenite and concentrated acid are fed continuously into a small, cast iron mixing vessel. Resulting slurry overflows into the lower end of an inclined, cylindrical, cast iron vessel fitted with an auger or paddle conveyor. The solid reaction mass is propelled to the outlet (higher) end of the reactor.

Added gimmick in the new process is addition of coke or charcoal to the reaction. This is said to increase rate of reaction and reduce rate of corrosion. It also results in liberation of SO_2, which helps keep the mass porous for easy dissolution in water.

Du Pont tried a similar approach more than 20 years ago but gave it up. Maybe the Aussies can make a go of it.

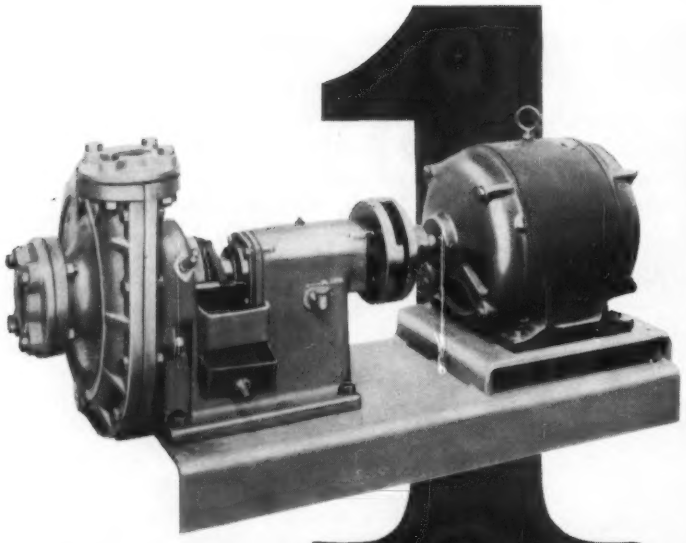
Uranium colors fertilizer picture

A new source of aluminum, phosphorus, uranium and even rare earths is the long-range hope held by TVA chemical engineers this month as they start up their brand-new demonstration plant at Wilson Dam, Ala., for production of fertilizer from Florida "leached-zone" phosphate ore.

Built at a cost of over $1 million, the new plant is designed to handle about 5 tons/hr. of ore. It provides facilities for calcining the ore, digestion with nitric and sulfuric acids, filtration, ammoniation and granulation.

Only product of the new plant, at least for the present, will be nitrophosphate fertilizer; uranium content of the ore (0.1-0.4 lb. U_3O_8 per ton) will be disregarded. TVA's immediate objective will be to establish the economics of fertilizer production. Development Chief T. P. Hignett thinks that nitrophosphate from leached-zone ore "could be profitable on a large scale at the right location."

(Continued on page 56)



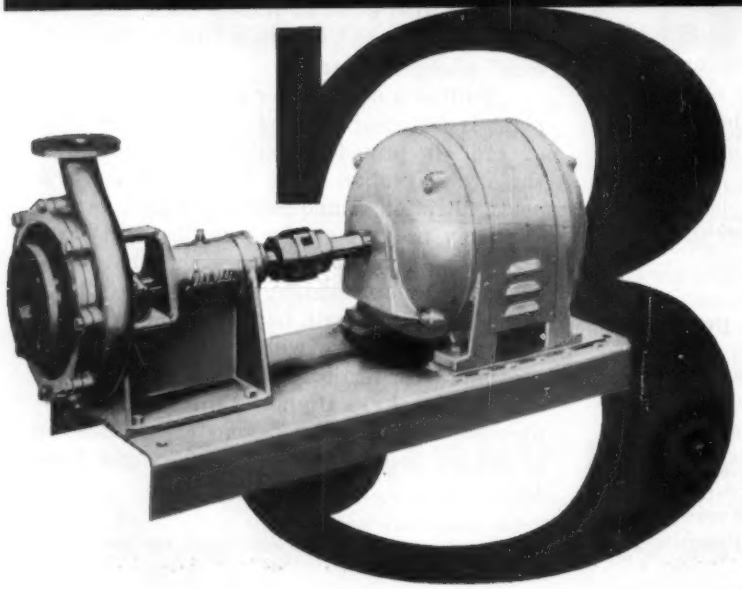
OLIVITE (LINED)

Acid Handling Pump provides maximum protection against corrosion and leakage, as well as ability to withstand a considerable range of temperatures. Casing, cover and impeller protected by a heavy covering of "Hypalon" elastomer. 1¼", 2" and 4" sizes, for V-belt or direct drive. Special rubber or neoprene lining in 4" size only.

only

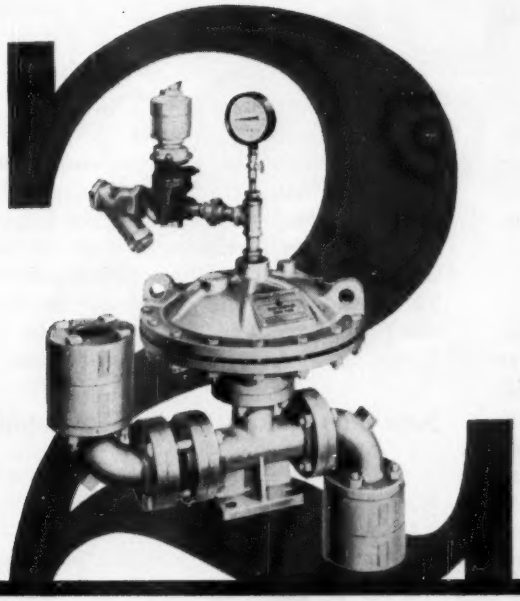
DORR-OLIVER makes 3 PUMP TYPES

for chemical processing



ALLOY (TYPE L)

Designed specifically for use with a mechanical seal, this pump has wide application in the chemical industry. Currently available in 5 standard sizes—1", 1¼", 1½", 2", and 3". Features include center line discharge, high cut-water or tongue of the volute—lifetime grease lubricated or oil lubricated bearings—choice of mechanical seals or stuffing box.

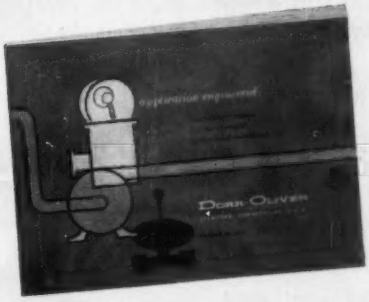


DIAPHRAGM (O.D.S.)

Operates without mechanical linkage – diaphragm is actuated by compressed air, vacuum, or a combination of both; controlled by 3-way solenoid valve. Handles abrasive slurries with up to 85% solids, at pressures up to 100 PSI. Available with diaphragm, ball check valves and lining of "Hypalon". 6 standard sizes handle flows from 1 to 90 gpm.

Send for this bulletin

Full dimensional, construction and performance data to help you solve your particular problems are given in this specially prepared bulletin. Write to Dorr-Oliver Incorporated, Stamford, Connecticut. Ask for Bulletin No. 5000.



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WORLD-WIDE RESEARCH • ENGINEERING • EQUIPMENT
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Complete pump coverage for the chemical industry

Whether you're handling acids or other corrosive mixtures, clear liquids, or slurries with a high percentage of abrasive solids, you're almost certain to find just the pump you need in the Dorr-Oliver line.

Dorr-Oliver is the only major pump manufacturer making three distinctly different types of pumps for complete coverage of the needs of the chemical and related industries. What's more, Dorr-Oliver's long experience in building chemical processing equipment and thorough knowledge of chemical industry problems assures the kind of performance and dependability you need.

Many Dorr-Oliver pumps already in use in leading chemical plants have long records of trouble-free and efficient service.

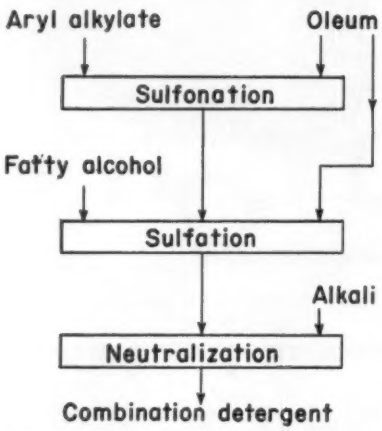
Olivite—Reg. T.M. Dorr-Oliver Inc

Hypalon—Reg. T.M. E. I. duPont de Nemours & Co.

AEC will be more than casually interested in TVA's findings. Commercial exploitation of leached-zone ore for its phosphate (or alumina) content would add appreciably to our economically workable uranium reserves. Processing of the ore for its uranium content alone would be too costly.

Present phosphate mining operations in Florida discard the leached-zone overburden, which contains 10-12% P_2O_5, while going after the richer matrix from which commercial phosphate rock (30-35%) is produced. Several years ago Blaw-Knox made an engineering and economic study for AEC on leached-zone nitrophosphate and published its findings (*Chem. Eng.*, Dec. 1954, pp. 120-122), but private industry was unimpressed. TVA hopes to work out cost-cutting improvements in the new plant which would make the process more attractive to commercial interests.

Integration better than segregation



Chemithon Corp., Seattle pioneer of continuous processing plants for making synthetic detergents (*Chementator*, July 1955, p. 110), has come up with a new wrinkle—the "tandem" process shown above. Company expects to deliver first such unit soon.

Alkyl-aryl sulfonates and fatty alcohol sulfates are both good detergents. Although they are strongly competitive for many markets, they sometimes team up to provide products combining their desirable properties.

By conducting sulfonation and sulfation steps in tandem, excess sulfuric acid from sulfonation is carried into the sulfation stage. Result, says Chemithon, is that less oleum is required in latter stage than in conventional segregated processing. Other reported advantages: Better conversion in second stage, more-homogeneous products.

Chemithon also reports successful use of chlorsulfonic acid in continuous sulfation of fatty alcohols to make salt-free detergents. Use of chlorsulfonic acid requires only a slight excess over stoichiometric requirements. This gets away from the need for neutralizing the usual excess oleum and thereby avoids formation of undesired sodium sulfate.

New plant pours forth radioisotopes

Recovery of isotopes from uranium fission wastes is due for a big boost as Oak Ridge National Laboratory readies its new $2.5-million multicurie fission products plant for full-scale operation. Dummy ("cold") runs started through the plant last month even as construction crews were still at work.

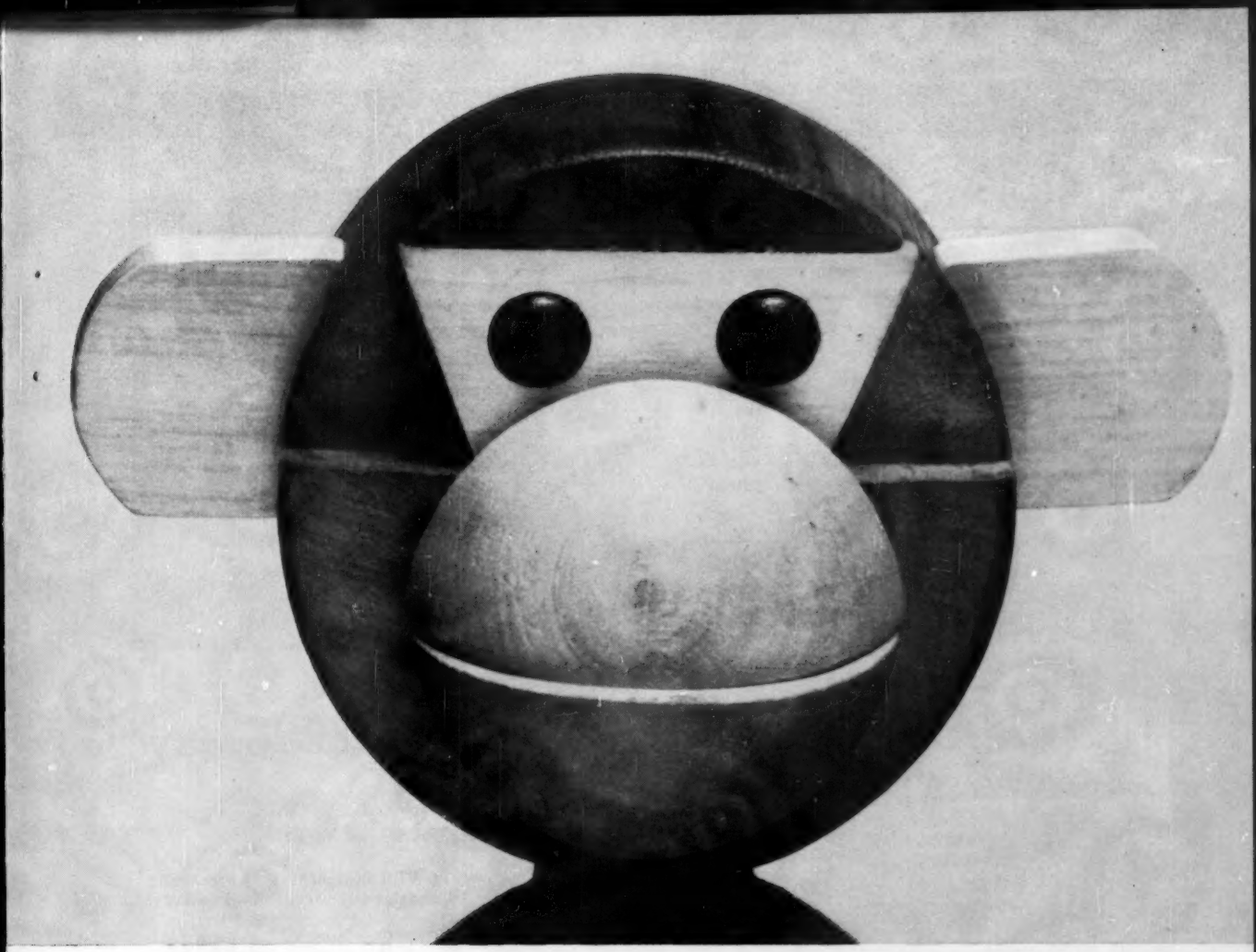
Plant is set up to handle a variety of wastes from chemical reprocessing operations which have previously recovered the uranium and plutonium contents of spent nuclear fuel. These wastes will come from such installations as the plutonium-producing reactors at Hanford and Savannah River and the materials-testing reactors at Arco, Idaho.

Principal products of the new Oak Ridge plant will be cesium-137, strontium-90, promethium-147, cerium-144, technetium-99 and ruthenium-106. They will be sold at prices based on "full cost recovery," which, says Isotopes Division Superintendent John Gillette, includes amortization of investment.

One of the first markets to be developed for cesium-137 is for use in teletherapy machines for medical purposes. Cesium-137 and other plant products also will find employment in irradiation devices, studies on radiation damage, catalytic effects and sterilization, and as energy sources such as "atomic batteries."

Processing of the fission wastes will follow methods similar to the separation schemes of the chemist's qualitative analysis laboratory. Primary separations will be made according to group (alkalis, alkaline earths, rare earths, etc.) in plant-scale stainless steel vessels and centrifugals. Isolation of some individual elements will be performed in king-size laboratory glassware.

All operations, of course, are carried out within shielded cells. The large equipment is operated by direct remote control. Glassware stages are also handled remotely with mechanical manipulators.



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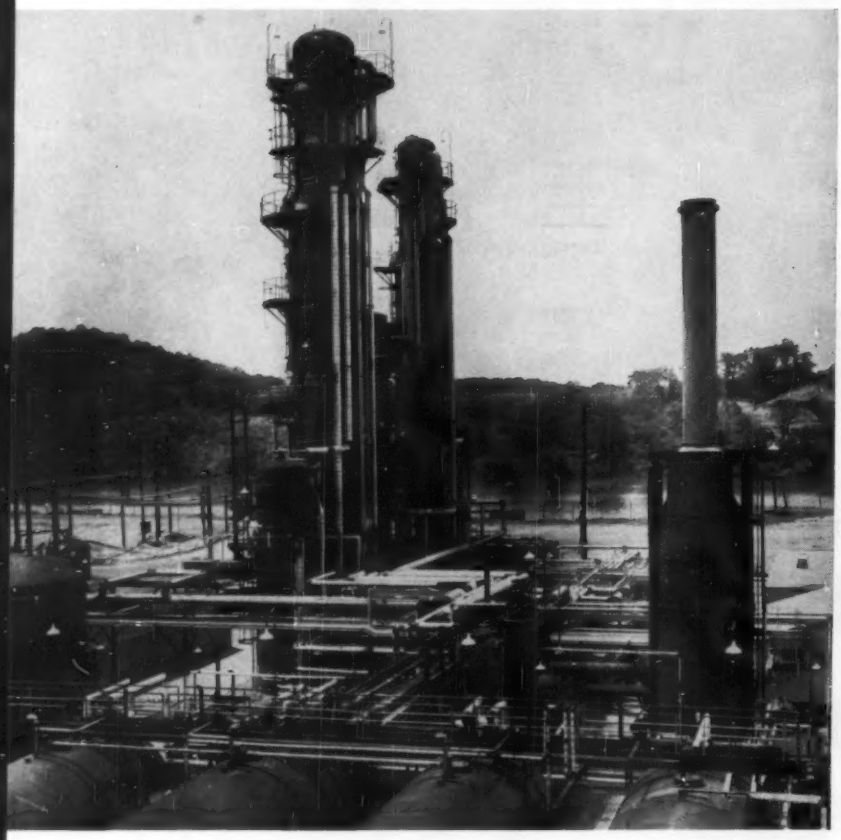


TOWER design hurdles processing obstacles in newest tall-oil refinery.

New Tall-Oil Plant Reflects Refining Know-How

- **Enlarged tower midsections reduce vapor velocity, entrainment and pressure drop.**
- **Perforated trays reduce pressure drop, steam requirements and cost.**
- **Data logging improves operation.**

LAST month, rosin-processing Monsanto Chemical Co. and fatty-acid-using Emery Industries announced full commercial operation at their new tall-oil refinery, Nitro, W. Va., less than one year after initial groundbreaking. Joint property of the two companies, plant is on a Monsanto site and run by Monsanto under a management contract.

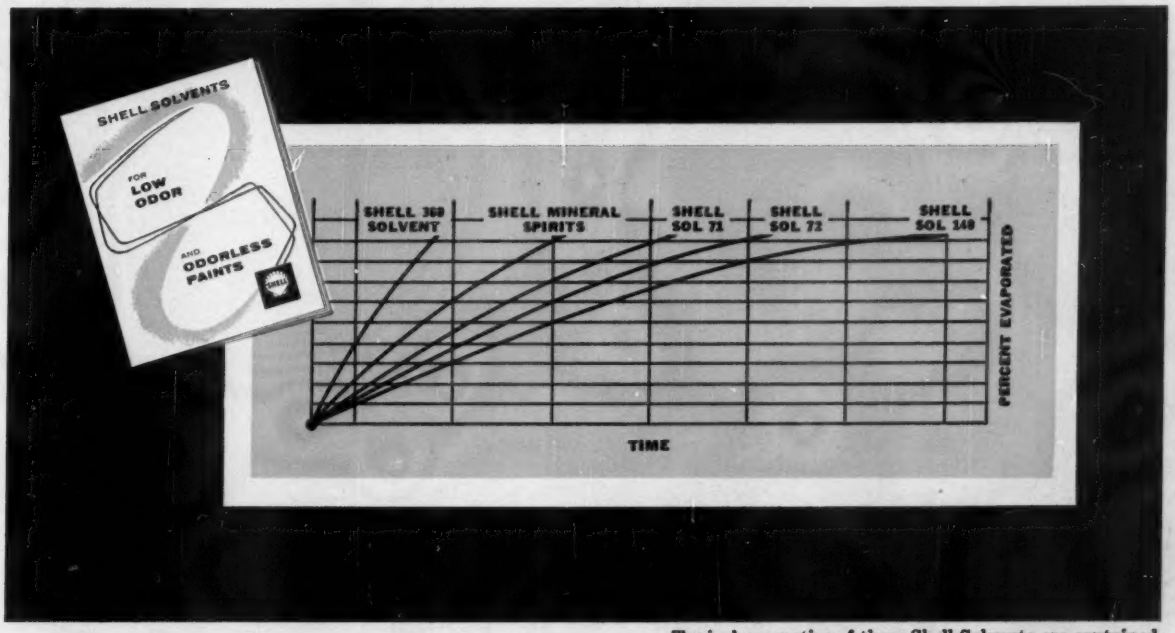
Processing 3,000 tons/month of crude tall oil barged in from St. Regis Paper Co. in Florida, Nitro turns out:

- Top-quality rosin for Monsanto's Mersize operation at Baxley, Ga., and for general sale.
- Unsaturated fatty acids for Emery Industries' Cincinnati operations.
- Saturated fatty acid, distilled tall oil and pitch for general sale.

Quality of products met specification within one month after startup. During the last week in June, Monsanto completed the circle by shipping to St. Regis the first Mersize derived from Nitro rosin.

Engineered and constructed by Badger Mfg. Co., refinery operates as a continuous flow-through system.* Using a series of vacuum towers, plant removes pitch, separates rosin from fatty acids, separates saturated from unsaturated fatty acids, minimi-

* For details on an intermittent-continuous process, see *Chem. Eng.*, June 1957, pp. 226–229.



Typical properties of these Shell Solvents are contained in booklet shown. It will be mailed on request.

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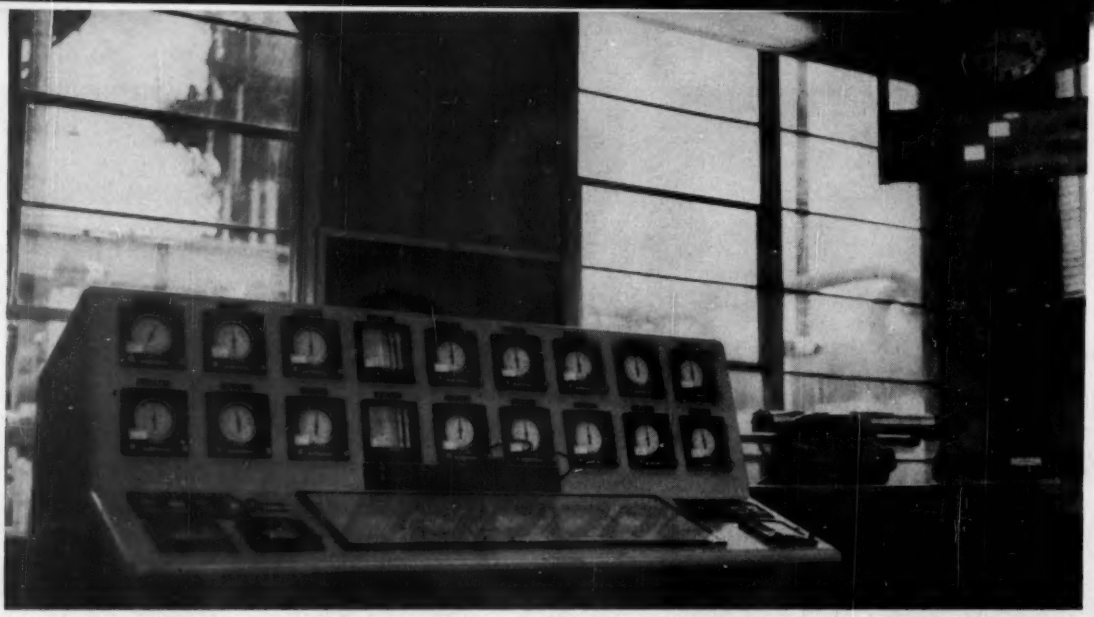


CONTROL center looks out on refining units, contains indicators (foreground), data logger (rt. background).

zes color bodies in the fatty acid.

▶ **Why Noteworthy?** — On the face of it, that's a pretty standard operation. But engineering features from Badger's bag of tricks produce some real operating advantages for Monsanto.

Crude tall oil is sensitive to heat. That means refiners must fractionate under vacuum to hold down temperature levels.

However, vacuum alone usually is not sufficient to suppress temperature. That's because a column high enough to give clean fractions normally would entail a high pressure drop from top to bottom.

To keep temperatures from rising higher than desired in the lower part of the column, operators commonly inject steam to depress the boiling points of the tall oil components. Disadvantages: greater heat requirements, larger equipment to handle added vapor flow.

▶ **Cut Pressure Drop**—Badger-Monsanto answer: Use specially designed perforated trays rather than bubble-cap trays, thereby reducing pressure drop, steam requirements, heat requirements and size of equipment. Furthermore, these trays handle higher throughput, cost less initially, are less expensive to maintain. And Badger has applied engineering skill to provide stable operation at considerably reduced rates, an unusual bonus for a perforated-tray column.

▶ **Condense in Tower**—To supplement the big advantage gained with perforated trays, the two main fractionating columns incorporate enlarged midsections above the feedpoint to minimize vapor velocity, reduce entrainment and, again, minimize pressure drop.

Overhead vapor condenses in cold liquid descending from special condensers built into the top of the tower. Circulating through external coolers, part of this stream recycles back to the internal condensers.

▶ **Other Features**—Although designed to operate continuously, the Nitro plant has separate steam-jet vacuum systems for front and back ends of the process. Together with adequate surge-tank capacity between ends, this feature permits temporary operation of one end should the other suffer emergency shutdown.

Initially, and at intermittent points in the process, the tall oil is heated by high-temperature heat-transfer fluid. Badger designed special heat exchangers to assure that no heat-transfer fluid can leak from shell into product.

Throughout the plant, equipment is stainless steel, with exception of aluminum storage tanks. These are blanketed with inert gas to prevent product degradation. Towers are stainless-clad steel.

Plant uses standard centrifugal pumps, with packing on hot liquids and mechanical seals on cold. Eventually, Supt. Warren Hinchcliff plans to install seals on some of the hot pumps.

▶ **Room With View**—Operators run refinery from a control center that offers a picture-window view of the entire facility. Miniature, 12-o'clock-reading indicators and controllers are mounted in two control consoles, with instrument locations marked clearly on accompanying small flow chart.

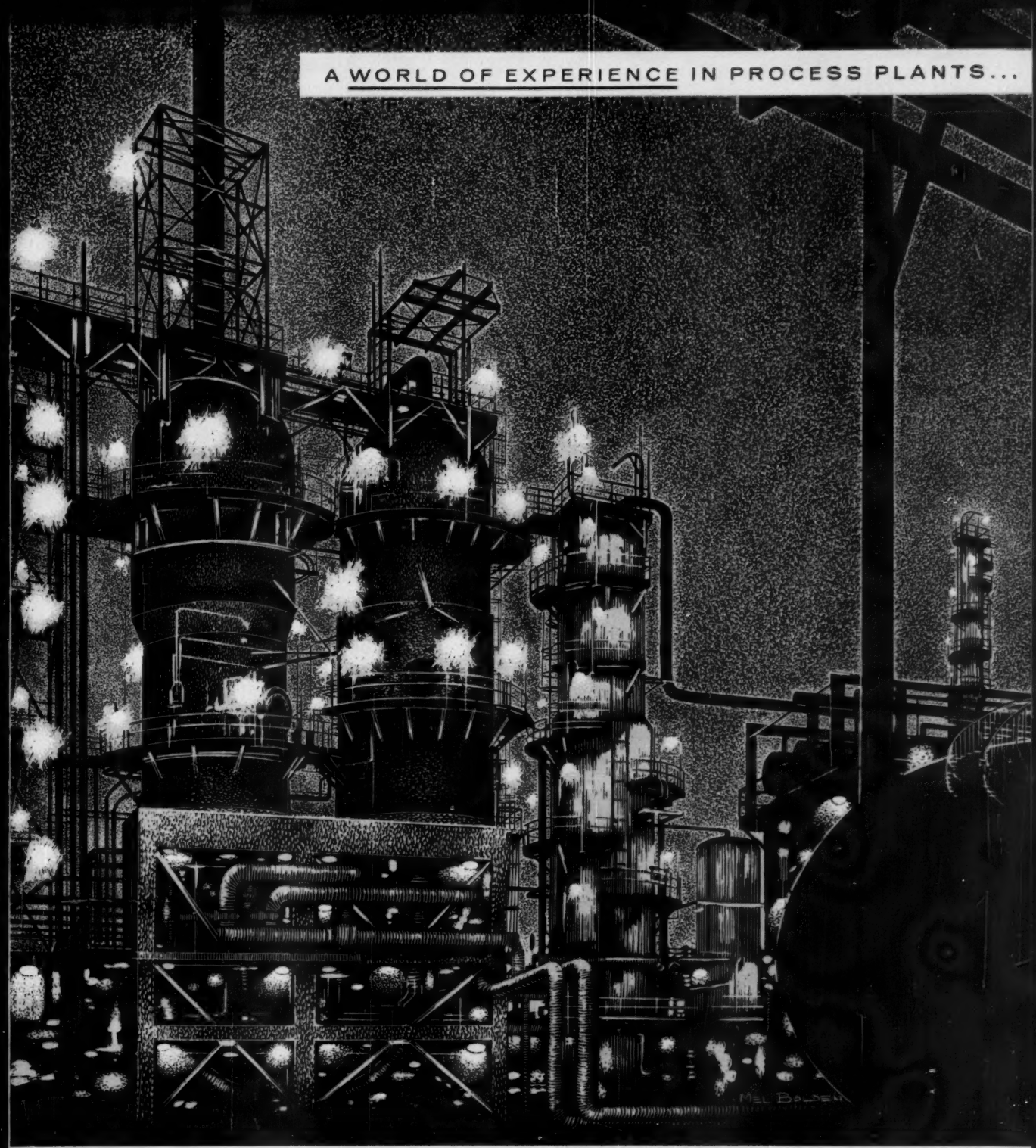
Another innovation for tall-oil refineries is the 70-point data logger. Normal values of temperature, flow and pressure print out in black at intervals of 15 min. or less, or on demand. Abnormal conditions immediately print out in red, simultaneously with warning flashed by annunciator alarm.

At the same time that digits print out on typewriter, they flash on face of logger panel in large, easy-to-read numbers. Operator can type in comments on log sheet to explain logged conditions.

Hinchcliff feels that logger has proven its worth by allowing operators to devote more attention to running plant. Too, it permits a given man to follow changes more rapidly.

As yet, no existing end-point analyzer can measure the product streams from tall-oil refining. Thus, operators adjust set points manually, based on laboratory analyses.

▶ **Crude to Product**—Crude tall oil feeding into the plant contains 41-45% rosin, 10-15% pitch and the balance fatty acids, together with a small amount of unsaponifiables and low-boilers.



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Fatty acid product contains more than 99% fatty acids and about 0.5% unsaponifiables; rosin is about 95% pure with less than 3% unsaponifiables.

Fast-Breeder Reactor Fuel Contracts Let

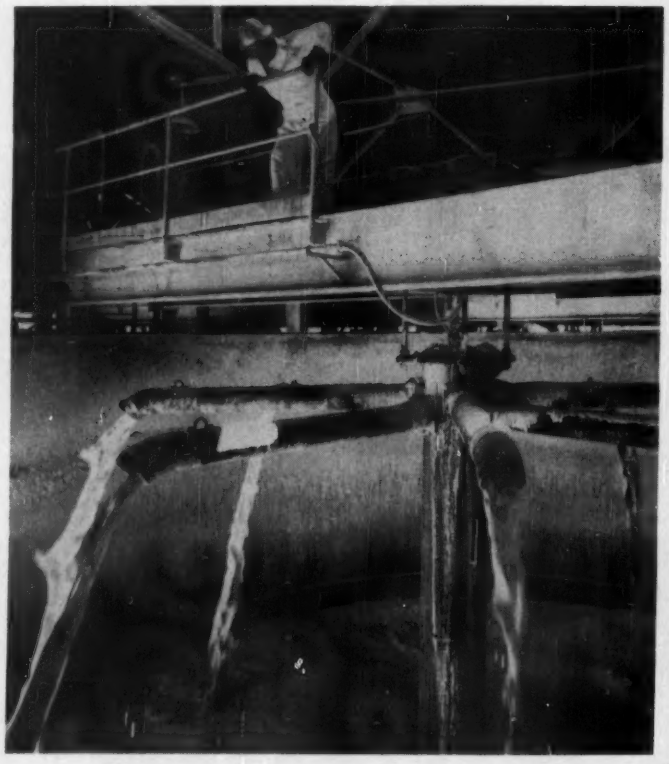
Uranium core and blanket subassemblies for the Enrico Fermi Atomic Power Plant initially will be produced under identical $1 million contracts awarded to Sylvania-Corning Nuclear Corp., Bayside, N. Y., and to Nuclear Metals, Inc., Cambridge, Mass., jointly with D. E. Makepeace Div. of Englehard Industries, Attleboro, Mass.

The Fermi plant is now being constructed near Detroit by Power Reactor Development Corp. Its 100,000-kw. reactor is first commercial fast-breeder type.

Sylvania-Corning and Nuclear Metals each are responsible for a complete seed core and one-half of the blanket assembly. Core is expected to last about a year; blanket, about two years.

Nuclear Metals' fabrication approach is typical: Alloy containing enriched uranium-238 and 10% molybdenum is melted and cast into 3½-in.-dia. billets to be extruded. Zirconium sleeves are bonded to each rod in coextrusion step. Makepeace will swage and draw rods to final ⅛-in.-O.D. Specifications call for 5 mil plus or minus 2 mil Zr coating on rods.

Core of the reactor is assembly of these clad enriched U-238 rods enclosed in stainless steel tube. Surrounding blanket assembly is similar but uranium is not enriched. During core fission process, the blanket fuel is changed to fissionable plutonium by neutron absorption.



New Alumina Plant Goes Into Full Production

With 38 precipitators, like the one shown above, swinging on stream, Ormet Corp.'s new alumina plant at Burnside, La., is now reaching its full 345,000-ton/yr. capacity. Above, sodium aluminate solution is pumped into 80-ft.-deep, 30-ft.-dia. precipitator. After this, aluminum hydrate seed particles are added to start formation of aluminum hydrate crystals. Product from plant is barged up Mississippi and Ohio rivers to Ormet's reduction plant near Clarington, Ohio. Ormet is jointly owned by Olin Mathieson and Revere Copper and Brass.

Canadian Pipeline Planned For Gas Byproducts

Natural gas byproducts from Alberta fields may be moved to Pacific markets by pipeline if a proposed "all-Canadian" project takes hold.

After detailed feasibility studies, a group of Canadian businessmen has incorporated Foothills Products Pipe Line Ltd. to advance plans for the 500-mi., $80-million job. Shell Oil Co. of Canada, among others, has been approached as a producer and prospective supplier.

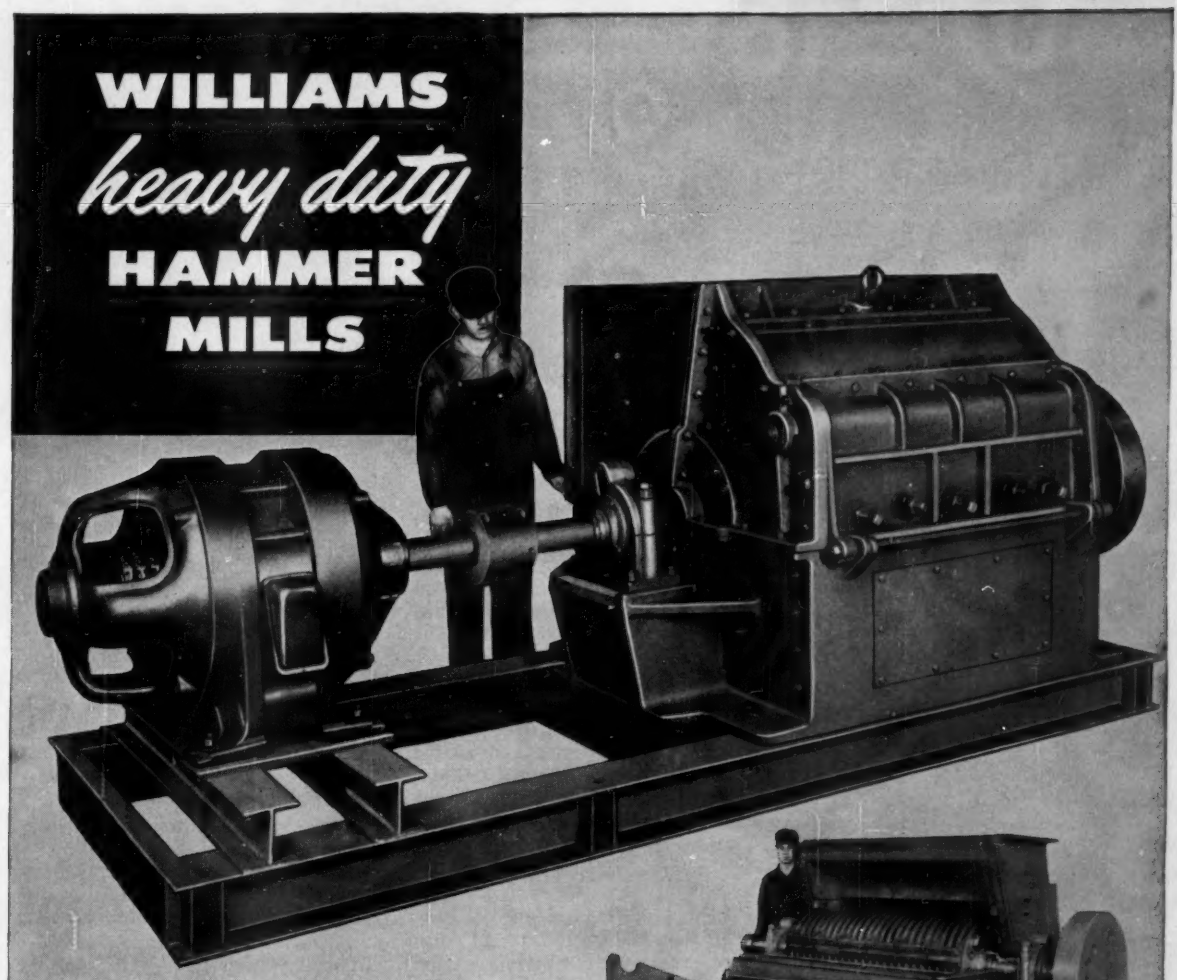
▶ **Pipeline Sulfur?**—Too, it's possible that sulfur—suspended in oil and water—may move through the pipeline.

Although Foothills does not confirm it, Shell Oil's holdings in sulfur-rich Okotoks gas field and contract research at the University of Alberta might indicate this (*Chem. Eng.*, Aug. 11, 1958, p. 71).

Outside opinion has it that a 12 to 16-in. line would originate probably in southwest corner of Alberta and terminate on lower mainland of British Columbia.

The company estimates that from $300 million to $500 million would be added to Canada's manufacturing economy through investment in the pipeline and in processing plants at both ends of the line.

WILLIAMS *heavy duty* HAMMER MILLS



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- **Reduces Production Costs Up To 50%**
- **Saves Up To 75% On Equipment Cost**

Williams No. 60 GA Mill with heavy duty steel plate frame. Cover has been opened to show heavy duty manganese steel liners, breaker plates, grate bars and hammers.

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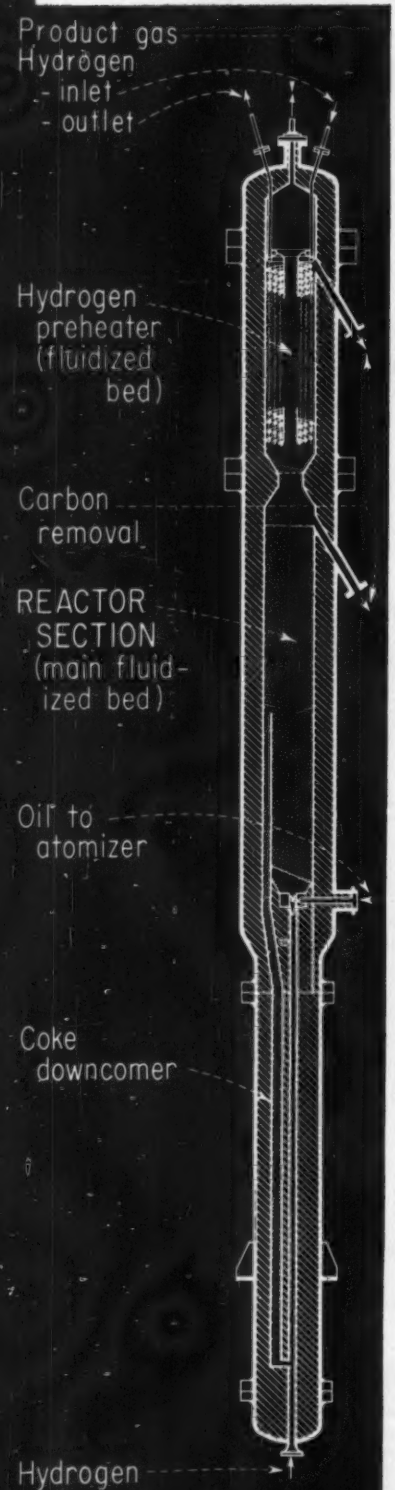

- **Direct hydrogenation matches conventional gas-making cost.**
- **Process yields sizable amounts of pure by-product benzene.**
- **Reforming portion of product gas provides feed hydrogen.**

BRITAIN has launched construction of three plants to produce methane by hydrogenation of oil via a new, non-catalytic, high-pressure, fluid-bed process. Object: To broaden the raw-material base of the nation's fuel gas supply.

Process was developed by Britain's Gas Council under the direction of F. J. Dent and piloted in a recently completed 1-million-cu.-ft/day plant at Solihull, the Gas Council's West Midlands research station.

In the U. S., somewhat similar work at the Institute of Gas Technology in Chicago (*Chem. Eng.*, Mar. 24, 1958, p. 121) has not reached commercialization because, for one thing, economic incentives are different.

▶ **Matches Existing Costs** — On the basis of Solihull operation, cost of gas produced by a $6.5-million, 7.5-million cu. ft. plant to be completed near Manchester, England, by 1960, will be 22¢/therm.

Gas Council considers this about equal to cost for conventional gas manufacturing. But in larger plants (outputs of 50 to 90 million cu. ft./day) for which the process is eminently suited, gas should be produced much cheaper than by conventional methods.

Basic reasons for economy of process are:

High Over-all Thermal Efficiency — hydrogenation is sufficiently exothermic so that, in a large plant, hot product gas can preheat cold hydrogen feed to 300-600 C. Typical thermal efficiency of hydrogenation stage is 95%.

Valuable Aromatic Byproduct — Reaction produces benzene amounting to 10-12% by weight of feed oil, plus a small quantity of naphthalene-rich tar. Benzene purity approaches synthesis grade because hydrogenation converts sulfur content to H_2S and strips off side-chains on the more complex aromatic hydrocarbons.

Requires No Oxygen — Although operating up to 1,000 psi., process does not use oxygen, and it produces a gas of low toxicity.

Adaptable to Many Feeds — While both Solihull and the Manchester plant now under construction are designed for crude or heavy fuel-oil feedstocks, process can be adapted to feeds ranging from low grade coal to light distillate. In fact, the Solihull pilot plant can process distillate as well as crude and will yield data over a range of conditions.

But Solihull produces fuel gas from only one feed material at a time. Hydrogen-rich gas for hydrogenation comes from an auxiliary plant which catalytically reforms part of the hydrogenator's product gas with steam, puts CO and H_2 through a shift converter and, then, scrubs out CO_2.

In the hydrogenator, feed oil sprays into the base of a fluidized bed of powdered coke which has hydrogen streaming through it. Powdered coke recycles to prevent agglomeration when using crude and heavy oils.

▶ **Solve Feeding Problem**—This recycle solves a major engineering problem. Early experiments showed that non-distillate oil introduced directly into the bed, even with an atomizer, failed to mix well with the hydrogen and caked the coke particles around the oil inlet.

Now, oil injected into a pipe

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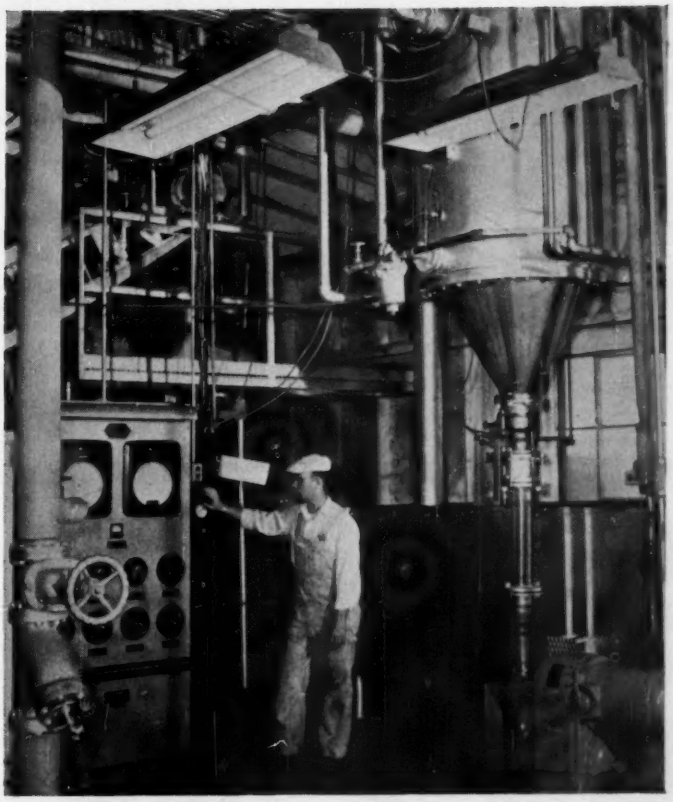

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For those who prefer to do their own testing and research, portable laboratory-size Turba-Film and Vacu-Film Processors are available for purchase or rental. With these units, thin-film processing techniques can be properly evaluated. Test results obtained from pilot-size Vacu-Film and Turba-Film Processors can be readily extrapolated to production-size units.

Please address your inquiries to the Process Equipment Division.

The Del Monte label has long meant superior quality in canned and processed foods. In producing Del Monte fruit concentrates, the California Packing Corporation uses a Rodney Hunt Turba-Film Processor to assure desired quality and character—a thick paste with fine flavor and good color.

Operating 24 hours a day during the peak season, this Turba-Film Processor maintains an excellent operating record with a minimum of maintenance. Pears and apricots are processed to a concentration of about 2.5 to 1 at a rate of 5 tons per hour—tomatoes to a concentration of about 3.5 to 1 at 3 tons per hour. And the equipment is readily variable to meet the different heating temperatures and operating pressures required for each product.

The taste and quality of the concentrate is protected from the injurious effects of overheating because of the precisely controlled, short-time exposure of the product in the thermal section. This is one of the most important advantages of the Rodney Hunt Turba-Film Processor—an advantage that has been widely applied throughout the process industries. Whether for chemicals, petroleum residues, pharmaceuticals and other temperature-sensitive products, the Turba-Film Processor will consistently and automatically retain the essential properties and desired qualities of the product being processed.

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loop, which recirculates coke particles from the fluidized bed, disperses into the large mass of fast-moving particles without causing agglomeration. Oil vaporizes and cokes rapidly, then hydrogenates slowly in the fluidized bed.

Differential head between the dense phase leg (see cut) on left-hand side of loop and light-phase leg on the right, recirculates the solids. Incoming hydrogen carries hot coke particles up the light phase leg to the bed at 10-20-ft./sec. velocity. Coke can recirculate at rates up to 20 times the weight of oil charged per hour.

▶ **Controlling Coke**—Non-distillate feedstocks such as crude oil and heavy fuel oil produce small quantities of coke on the fluidized particles which can be recovered. In general, the yield is about one half the carbon residue figure for a given oil.

By-passing some of the fluidized bed through a grinder within the pressure system controls coke size. Surplus coke bleeds off near the top of the hydrogenator.

In the case of distillate feedstocks, the oil is vaporized externally and enters with the hydrogen at the base of the reactor. When using non-distillate oils, however, external preheating is limited to 350 C.

▶ **Second Bed Quenches Gas**—A second major engineering problem solved with the Solihull design was how to quench reaction products leaving the hot fluidized bed. If products are not quenched below 600 C. immediately, continuation of the exothermic reaction in the space above the bed and in the discharge piping can overheat the equipment seriously.

By superimposing a second fluidized bed above the reaction bed, the Solihull design provides for heat exchange between the hot product gases and cold hydrogen feed gas. Hot gas gives up heat to the fluidized particles in the second bed, which in turn release heat to a coil in the bed. Thereby, temperature of hydrogen passing through the coil rises to about 500 C. while product gas cools to 600-650 C. An external, gas-fired heater boosts hydrogen to 650 C., if required.

Product gas leaves the top of the unit through an internal cyclone.

▶ **One Package for All**—At Solihull, reaction zone, coke recycle section and heat exchange section are all contained within a single, 1,000-psi. vessel, 56-ft. long and 3½-ft. dia. Pressure is controlled primarily by a system outlet valve which is adjusted to suit the rate at which oil and hydrogen are fed in.

Heat exchange section is 2 by 8 ft., coke recycle section is 22 ft. long. Reaction section, 17 ft. long, contains a fluidized coke bed 2 ft. dia. by 16 ft. deep.

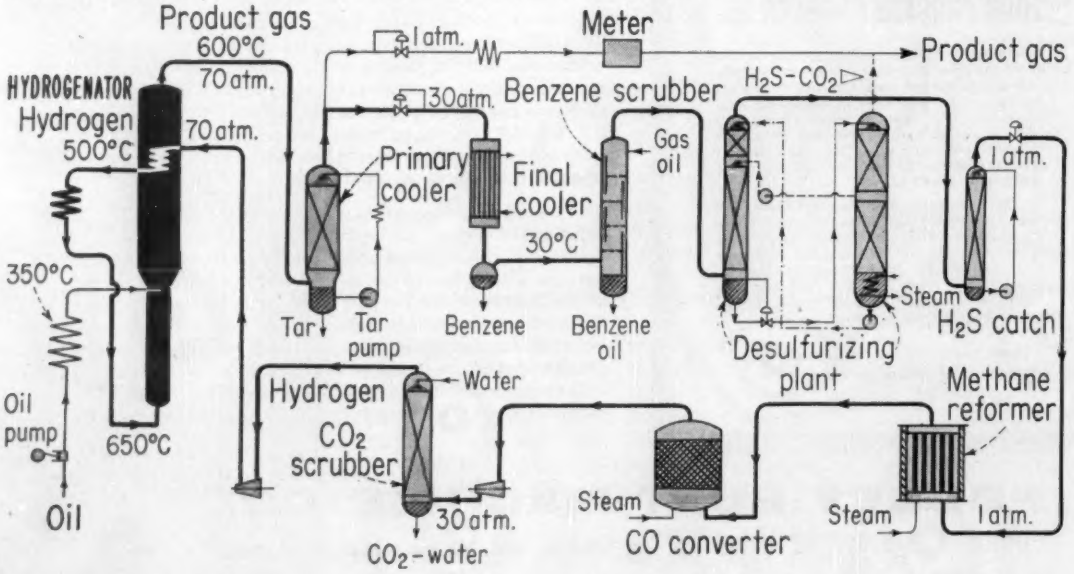
▶ **Cool and Purify**—Hot product gas undergoes cooling in tower packed with Raschig rings by scrubbing with recycled cool tar. Tar stream removes from gas the tar formed during hydrogenation plus any coke dust that carries over from fluid bed.

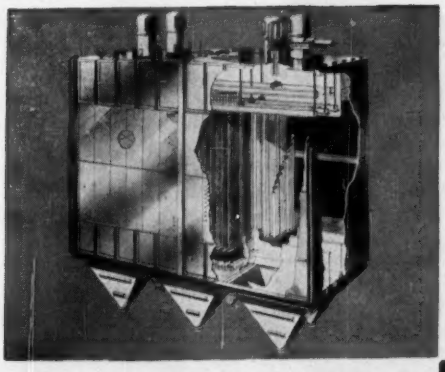
Cool gas in excess of that needed for catalytic reforming into hydrogen-rich feed gas is flared at Solihull after sampling and evaluation.

Recycle stream is depressured to 20 atm. then is cooled to 30 C. to condense benzene. Any benzene vapor remaining in gas is scrubbed out with gas oil in a bubble-cap absorption column at 26.5 atm. (375 psig.)

A Benfield purification plant removes H_2S and most of the organic sulfur from the gas, using hot 40% potassium carbonate pressure washing technique developed by the U. S. Bureau of Mines. Washing takes place in packed tower with recirculating carbonate solution, while adja-

HYDROGENATOR feeds hot gas to cooling, purification and reforming equipment.





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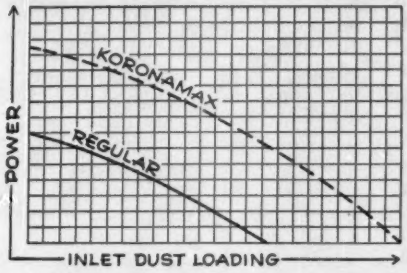
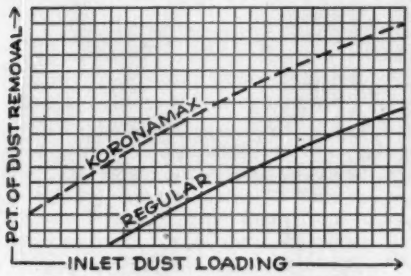
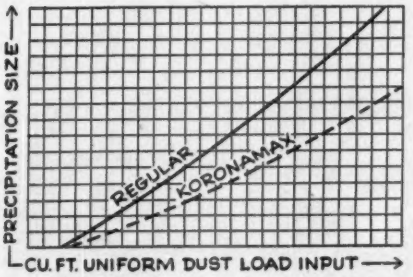


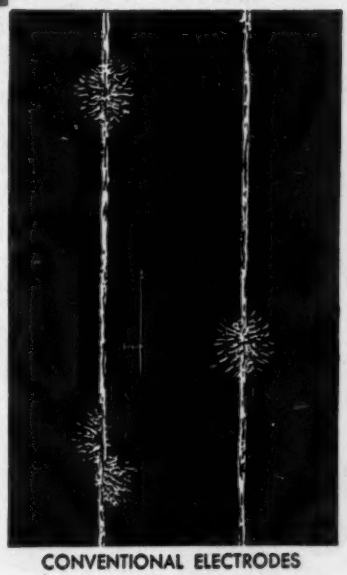
INCREASED POWER—The evenly spaced discharge points of "Koronamax" Electrodes reduce the arc-over tendency and permit increasing power input.



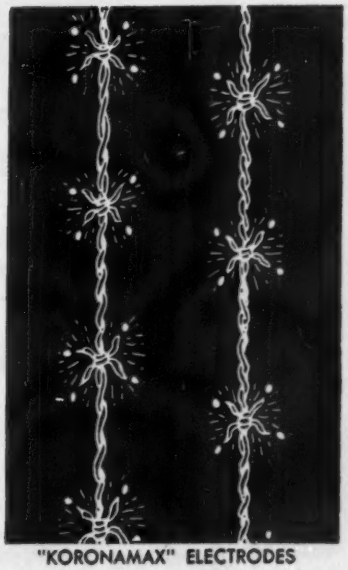
HIGHER EFFICIENCY—Replacement of regular electrodes with "Koronamax" Electrodes allows higher power input — greatly increased efficiency.



SMALLER SIZE—In new installations desired efficiency may be obtained with smaller unit when "Koronamax" Electrodes are used.



CONVENTIONAL ELECTRODES



"KORONAMAX" ELECTRODES

"KORONAMAX" ELECTRODES increase efficiency and capacity of electrostatic precipitators

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Koppers' experience, constant research and extensive field testing have led to this important advance in precipitator design. Check with Koppers to see if "Koronamax" Electrodes can help you get top precipitator efficiency. For more information, write: KOPPERS COMPANY, INC., 9708 Scott Street, Baltimore 3, Md.

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cent tower simultaneously regenerates sulfur-laden carbonate stream. Designed to handle 3/4 million cu. ft./day of gas containing 1% by volume H_2S, plant removes up to 98.5% of sulfur.

Final traces of H_2S are removed by cleanup scrub with 30% caustic soda solution before gas undergoes depressuring to near atmosphere and passes to hydrogen production plant.

Gold to Aid Engineers In Mud-Migration Battle

If you happen to be in the vicinity of San Francisco Bay in the near future, don't be surprised if you come upon a group of engineers busily seeding the bay bottom with gold.

The engineers belong to San Francisco district, Corps of Engineers, U. S. Army. The gold isn't ordinary gold; it's radioactive. Purpose of this apparently strange behavior is to trace some 6 million cu. yd. of silt that annually drift into the ship channel and are then dredged out at a cost of $1 million. By using radioactive tracers to chart silt flow, engineers hope to find a way to lick this costly mud migration.

This is the Army's plan of attack: Several barrels of mud will each be seeded with one curie of radioactive gold. This mud will then be dumped at the source of the shifting silt and an Army service boat will regularly check the water surface with a scintillation detector to find out how fast the mud moves and where it is headed.

Radioactive gold is ideal for this project because its short half-life (three days) prevents it from harming human or aquatic life. This method of silt tracing has already been used with some success in coastal harbors of Japan and England, according to district engineer Col. John S. Harnett.

Propylene and Isoprene Via Houdry-Process Path

Houdry's dehydrogenation process now opens up new avenues to propylene and isoprene. With interest in propylene sparked by "directed" polymerization of olefin (*Chem. Eng.*, Feb. 24, 1958, p. 88) and interest in isoprene stirred by successes with synthetic "natural" rubber (*Chem. Eng.*, Dec. 1955, p. 108). the route will receive careful attention.

Pilot plant data indicate high molar selectivity for propylene from predominantly propane feedstock. A 96%-propane feed stream will yield a 77%-propylene product stream. In case of isoprene, a typical catalytically cracked C_5 fraction consisting of *iso*- and *n*-pentanes and pentenes will yield 41% isoprene in product.

The Houdry process, first introduced during World War II to produce butadiene from *n*-butane, converts light paraffin hydrocarbons to corresponding mono- and diolefins with minimum side reactions. Preheated feedstock is fed to refractory-lined carbon steel reactors. The endothermic reaction takes place in chromia-alumina catalytic bed at about 1,100 F.

Hot reactor effluent is oil-quenched, after which light gases are separated and pass to plant fuel system. Desired fraction components are separated in olefin extraction section with raffinate recycled back to reactor feed.

Boosting Temperature Also Boosts HCN Yields

Joining the march towards higher and higher reaction temperatures, the German firm of Deutsche Gold-und Silber-Scheideanstalt (Degussa) has just unveiled its new catalytic process for making hydrogen cyanide from ammonia and methane. Process highlight: 88% yield (based on ammonia—the most expensive raw material) compared with 75-80% yield for the older Andrussow process.

Degussa's process, embodied in a new 100-ton/mo. plant, operates at 2,000-2,500 F., several hundred degrees higher than Andrussow process. Moreover, Degussa route doesn't use air as a raw material.

Key to process' high-temperature success is a new furnace utilizing sintered alumina reaction tubes. Furnace has eight chambers, each holding a vertical bundle of 13 alumina tubes. Six gas burners in each chamber provide the 100 kcal./mole needed to sustain reaction. Tubes, 6.5 ft. long and 0.8 in. dia., are coated inside with a thin layer of platinum-based catalyst.

▶**Brief Process Rundown** — Ammonia and methane react in alumina tubes giving a product gas containing 20% HCN, 70% H_2, with remainder consisting of CO, N_2, unreacted methane and ammonia. Gases are cooled and passed to sulfuric acid washing towers to remove ammonia. Scrubbing with NaOH recovers HCN; aqueous solutions of HCN can also be produced by scrubbing with water instead.

Along with every ton of HCN produced, plant also manufactures 88,000 cu. ft. of hydrogen and 14,000 lb. of 150-psi. steam.

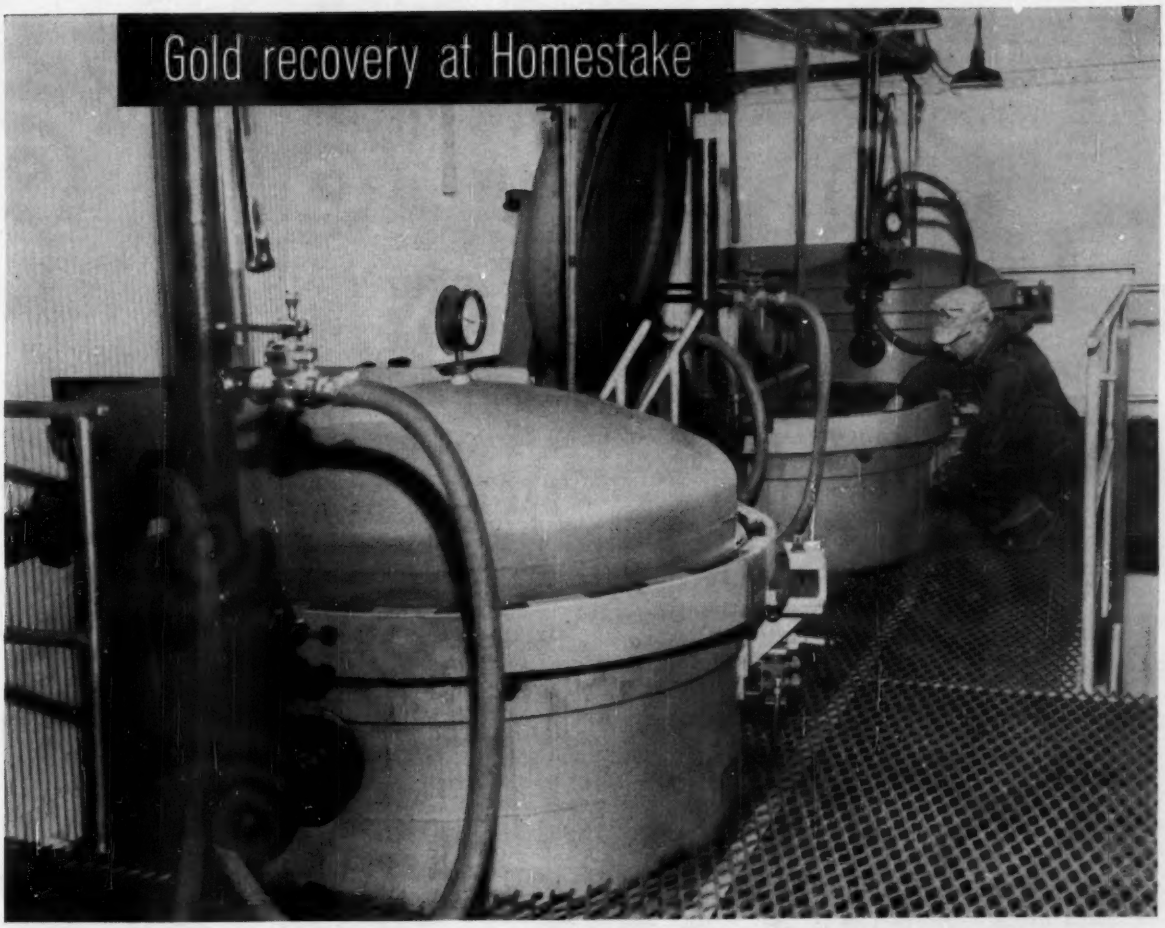
NEWS BRIEFS

Sulfate pulp: Eastern Corp. has started up its $11-million, 175-ton/day bleached-kraft-pulp mill at Lincoln, Me. Installation boasts a Kamyr continuous digester primarily for hardwood pulping.

Tantalum and columbium pentachlorides: Stauffer Chemical Co. is building a semi-works installation, at a cost of over $300,000, to produce tantalum and columbium pentachlorides at Richmond, Calif.

Rocket engine: Rocketdyne Div. of North American Aviation will develop a rocket engine for the Air Force in the million-lb.-thrust class. Engine will be liquid-fueled, similar to engines in Atlas ICBM.

Solid gasoline: Russia's Antarctic station is being partly fueled with solid gasoline that can be stored without container at temperatures from 120 F. to −75 F. Gasoline is solidified by injecting special additives, then reliquified before combustion by a special press installed in vehicles.



Process Filters help wring precious metal from stubborn ore

Tough and hard, the gold bearing rock of South Dakota clings stubbornly to the tiny particles of precious metal it contains. To extract gold from the ore, Homestake Mining Co., Lead, S. D., grinds the rock to a fine powder, then dissolves the rare metal with a solution of sodium cyanide.

After the ore slurry is passed through Merrill presses, the ongoing solution must be cleansed of all inert matter and residue before the gold is precipitated. Three Process Model V470-2 Filters do the job, clarifying the gold-bearing cyanide stream at better than 54,000 gallons per hour. Covered with Process Quick Change Bags, filter leaves are cleaned by newly-developed rotary sluicing headers which remove the cake rapidly and completely.

Says Homestake Mining Co., "Choice was made mainly on a filter with sufficient capacity to handle the job, yet small enough to fit into the area available . . . Process Filters' service has been satisfactory."

Combining rapid flow rates with proved dependability, Process Filters are raising performance standards throughout the chemical and petrochemical industries. Both standard and specially engineered units are available with a wide range of accessories to meet your process requirements.

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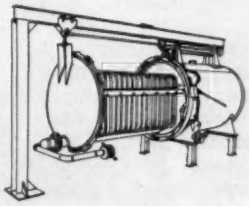
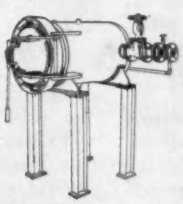

HORIZONTAL LEAF FILTERS
Bulletin H


HORIZONTAL BATCH FILTERS
Bulletin HB

CARTRIDGE FILTERS
Bulletin C

pf

DEVELOPMENTS...

CHEMICAL ECONOMICS

EDITED BY D. R. CANNON

Russia / Inflation / Atom Power / MAPI

- **Soviet plastics industry? Crude but coming fast.**
- **Inflation from bigger deficits? Not necessarily.**
- **Atomic power a cinch? Oil, coal aren't pushovers.**
- **Want to modernize? Try new MAPI formula.**

• Russian Chemicals: Strength, Weakness

The Russians have a lot to learn about chemical and plastics production. But their industry is ambitious and an all-out research effort is teaching them fast.

This is the inescapable conclusion from the reports of several U. S. industrial leaders and scientists returning from a tour of 15 plastics and chemical plants and five research centers in the Soviet Union.

Brooklyn Polytechnic's polymer expert, Herman Mark, says Russian polymer research "is of good quality" and rates at a level of 30-40% of U. S. polymer research and development. One thing helping the Soviet research effort is the equipment available for it. Mark says "there exists a high-level precision instrument industry on a fairly large scale in the Soviet Union."

Some specific research results noted by observers:

- A nylon-type material, polyoenanthic acid amide, based on ethylene, is being made into continuous filament and staple fiber on a pilot-plant scale.
- Linear polymers of vinyl acetate and chloride made by polymerization with boron alkyl catalysts like triisobutylboron.
- A novel process to manufacture isoprene.
- New polymers—like diisopropyl ferrocene, diphenyl diisopropyl silicate—via a new principle: polymerization through bifunctional recombination at moderate temperatures (fewer side reactions). Products have high melting points and may be molded, cast or spun.

As far as production goes, the Russians lack for finesse more than any other one thing.

They don't bother with waste recovery. Fire protection devices are almost nonexistent, according to Thomas Kinsella of Allied Chemical.

Product quality is uneven, with the number of styles and colors held to a bare minimum. In urea and melamine resins, for example, the Russians aren't too concerned about contamination and color control.

▶ **Plenty of Help** — Chemical plants tend to be overstaffed, largely because of a dearth of materials-handling equipment. In all the plants visited, Allied's Kinsella saw only one lift truck. In the 40-million-lb./yr. phenol plant near Grosny, operating labor was three times what it would be at a U. S. plant.

Nevertheless Soviet plants are producing most of the plastics we are, although sometimes in little more than pilot-plant quantities.

"No coal tar is being burned in Russia; coke and byproduct plants are very modern" says Kinsella.

In a totalitarian economy, of course, industry has no inventory problems. Everything is shipped as soon as it's manufactured. The simple product patterns help distribution, too.

▶ **Womenpower**—Russian chemical industry has built-in manpower insurance: womenpower.

Kinsella reports that in practically all Russian plants the operating labor is female. Right up to the assistant plant manager. Control-board operations are handled by the fair sex.

There are many other examples of the pattern of weakness and strength running through the Soviet plastics and chemical industry.

While the Russians are far behind in polyethylene, polyvinyl chloride and synthetic fibers, they do produce such things as silicones and fluorocarbons.

Soviet injection molding looks slow and laminating quality is poor. Yet their compression molding of conventional plastics is comparable to ours.

Sizable tonnages of caprolactam nylon are being turned out in the Soviet Union. Polypropylene hasn't gone commercial as yet.

But the Soviets are most certainly in earnest. Total plastics output may exceed 1 billion lb./yr. One Russian, Dr. S. E. Bresler, says the USSR will spend $10-20 billion to expand current chemical and plastic facilities. The Soviets expect to step up production of plastics 800% and fibers 400% in the next seven years.

• Deficits Don't Always Breed Inflation

Our federal budget for fiscal year beginning July 1, 1958, will show the largest peacetime deficit ever—$10 billion. And this estimate may turn out to be conservative. We may have to accept deficits in the range of $10-15 billion over the next three years even if business and tax revenues recover to pre-recession levels.

Will the deficit cause inflation?

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No, not immediately, writes Robert Ulin of Mc-Graw-Hill's Dept. of Economics. And maybe not for a long time. However, to the extent that a federal deficit is financed by borrowing from commercial banks, it creates possibilities for eventual price inflation because the total supply of money in circulation is increased. And prices depend on how much money is chasing the available supply of goods.

But we have safeguards, Ulin points out, against another round of inflation:

• The power of the Federal Reserve System to govern the use of bank credit. After World War II the Federal Reserve Board, bound to support the market for government bonds, had to buy back these bonds at par whenever banks offered them. Today, the FRB allows bond prices to fluctuate and can refuse to purchase bonds except at lower prices. This discourages banks from selling bonds for cash to make new loans.

• Our large reserve of manufacturing capacity. Any likely new demands for consumer goods can be met quickly and easily. Unafraid of shortages, consumers are unlikely to bid up prices. And corporations will be slow to start the kind of massive expansion programs that lead to pressure on costs of construction and capital goods. (After the two most recent wars industry was catching up with shortages of capacity accumulated during depression and war years.)

Of course there is danger, a very real one. Upward pressure on many prices—rents, services and others—comes from nonmonetary factors—especially the upward push of wages. How much pressure depends heavily on the amount of money circulating. By 1960 there will be $25 billion in new "Sputnik" money circulating in this country.

Almost everything depends on a business recovery before too long. Recovery will increase revenue and reduce the potential deficits and the increase in money supply. Recovery will permit a gradual increase in consumer and capital expenditures rather than an explosive burst in demand.

Assuming, then, a not-too long recession, the supply of most goods will be ample to meet any demand and "the deficit, properly managed, need not lead to a disastrous wave of inflation."

• Atomic Power Can Level Regional Fuel Costs

Whatever absolute share atomic energy claims of the nation's total needs in the next 25 years, it's impact will be apparent across the land. It will wipe out regional differences in energy costs. Industrial locations will be decided on the basis of other factors, such as markets, manpower and raw materials. We might have major steel complexes, for instance, in Minnesota and on the Gulf and Atlantic Coasts.

This is how the atom's near-future role is appraised in a recent study by the National Planning Assn.

Compared to some previous predictions, NPA's survey views atomic potential for 1980 rather conservatively: Only a $10-billion industry, accounting for but 21% of total power generation, 29% of electric power, 24% of marine propulsion, 10% of railroad locomotion, 15% of process heat, 7% of all heat.

What will limit atomic-energy inroads to these figures? According to NPA, cost of conventional fuels will rise only 15-25%—in terms of stable dollars—over the next 25 yrs. Thus, atomic energy costs will have to come way, way down to compete successfully in oil's and coal's backyards.

Atomic energy may catch on fast in fuel-starved regions—and give the more homogeneous industrial pattern mentioned above. But atomic energy will wait a long time for coal, oil and gas to price themselves out of the market in fuel-producing areas like Pittsburgh and the Gulf Coast.

One-fourth of the nation's estimated coal reserves of 943 billion tons is recoverable at present prices. With annual consumption running at but half a billion tons, there's little likelihood of a coal price increase.

Proved oil reserves of 35 billion bbl.—a 13-year supply—could be bolstered with 184 billion bbl. already discovered and waiting for more economic recovery methods. Oil shale reserves, figured at 900 billion bbls., could yield 45 billion bbls. with present techniques at near-present prices, says NPA.

So figuring atomic energy's role in terms of a percentage of the national demand is risky and misleading. The atom's true worth in the next 25 years will be felt in the villages of New England and North Dakota.

• Broader Formula Eases Modernization Decision

Chemical processors with a notion to modernize have a better analytical tool for assessing individual investment proposals and ranking them in order of priority. The Machinery and Allied Products Institute (MAPI) formula, one of capital budgeting's classical methods, has been strengthened.

By far the most significant advantage claimed for the new MAPI system is that it directs attention to all advantages of a proposed project, not just its advantages over certain facilities slated for retirement.

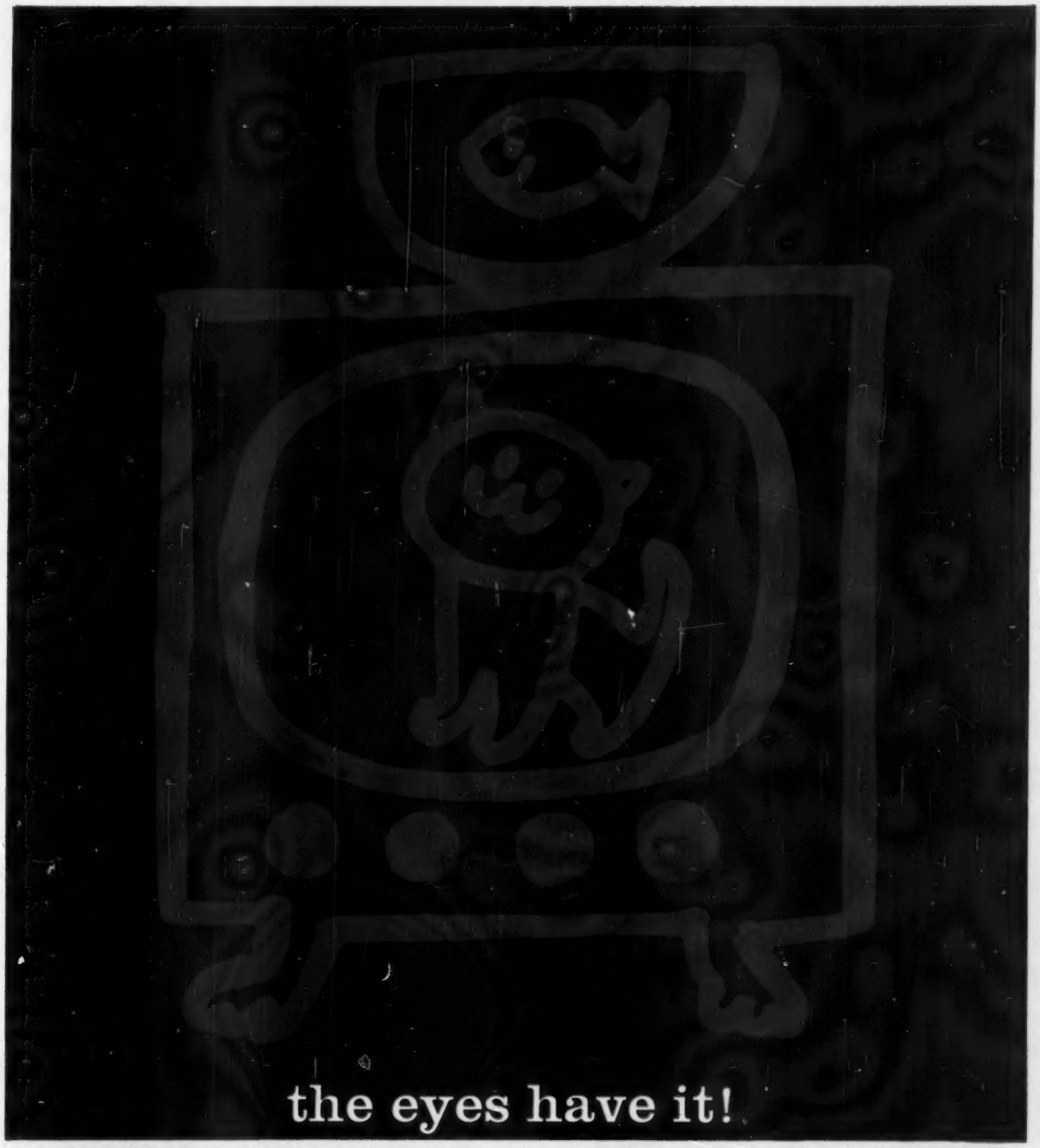
The MAPI formula no longer poses a contest between a new piece of equipment and an old item to be replaced by the new. Now, says its sponsors, it can screen all kinds of investment opportunities—replacements, expansions and completely new projects—by comparing an entire operation with the investment and without it.

Other changes in the MAPI formula:

• A choice of three projection patterns for depreciation and obsolescence over an asset's life: constant rate, accelerating rate and decelerating rate.

• An exact adjustment for the particular method of tax depreciation specified, instead of loading the formula interest rate to approximate the income tax.

• Elimination of special terminology in the original formula, gobbledygook which proved a real semantic barrier to acceptance by practical operating men.



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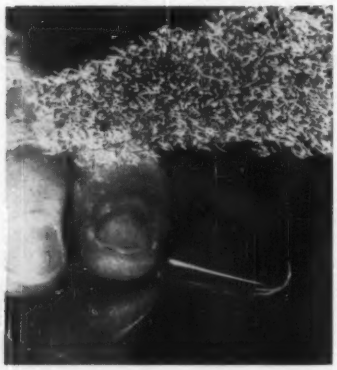


Aluminum Grains

New size and shape are shown as tweezers pick a grain from pile spread on glass.

A new metal product described as "bridging the gap between aluminum shot and aluminum powder" is now being marketed.

Formerly there was no aluminum granule of controlled particle size and shape which came between powder and minus-five mesh shot. The new long, irregularly shaped particles provide a much greater surface area per unit of weight than does aluminum shot, and at much less cost than aluminum powder.

In the initial two standard sizes, the larger—300-X granules—range in diameter from .132 in. to .02 in. The smaller—200-X particles—are from .08 in. to .01 in. in size.

The development of solid fuels and new chemical processes makes finely divided aluminum particles extremely important in today's chemical technology. In reaction with oxygen, aluminum gives off a tremendous amount of energy per unit of weight. The greater the surface area of aluminum, the faster will be the reaction between the metal and the oxygen.—**Reynolds Metals Co., Richmond, Va.** 74A

Polybutadiene Rubber

New rubbers, via stereospecific catalysis, approach natural's properties.

Firestone has developed a new rubber made from butadiene, with lithium metal derivatives used as a catalyst. Called Diene, it was developed as a rubber extender.

Although various catalyst systems can be used to prepare rubbers from butadiene, the system favored by Firestone utilizes lithium metal derivatives similar to those used in the Coral rubber system. Coral rubber, which is similar to natural rubber and was developed several years ago by Firestone, is made with isoprene as base material. This is also true of other "synthetic" natural producers, Goodrich and Goodyear. However, they use Ziegler-type, rather than lithium, catalysts.

▶**Li Varies Structure** — Diene rubber, according to Firestone, is substantially different in polymer structure from that obtained with Ziegler or modified Ziegler-type catalysts. However, rubbers prepared from butadiene by the various catalyst systems give about the same performance when blended with natural Hevea rubber and used in tires and other rubber products.

The system and catalyst chosen by Firestone make Diene rubber readily adaptable to the 500-gal. reactors in the Coral rubber pilot plant in Akron where sufficient has been produced to evaluate it in passenger and truck tires.

The tests indicate that Diene can be used to replace a substantial portion of the natural rubber in truck tires. The results are: marked improvement in crack resistance, satisfactory running temperatures, greatly improved skid-resistance due to Diene's pliability at low temperatures.

When Diene is blended with natural rubber, the temperature build-up in truck tires is comparable to that of tires made entirely with natural rubber.

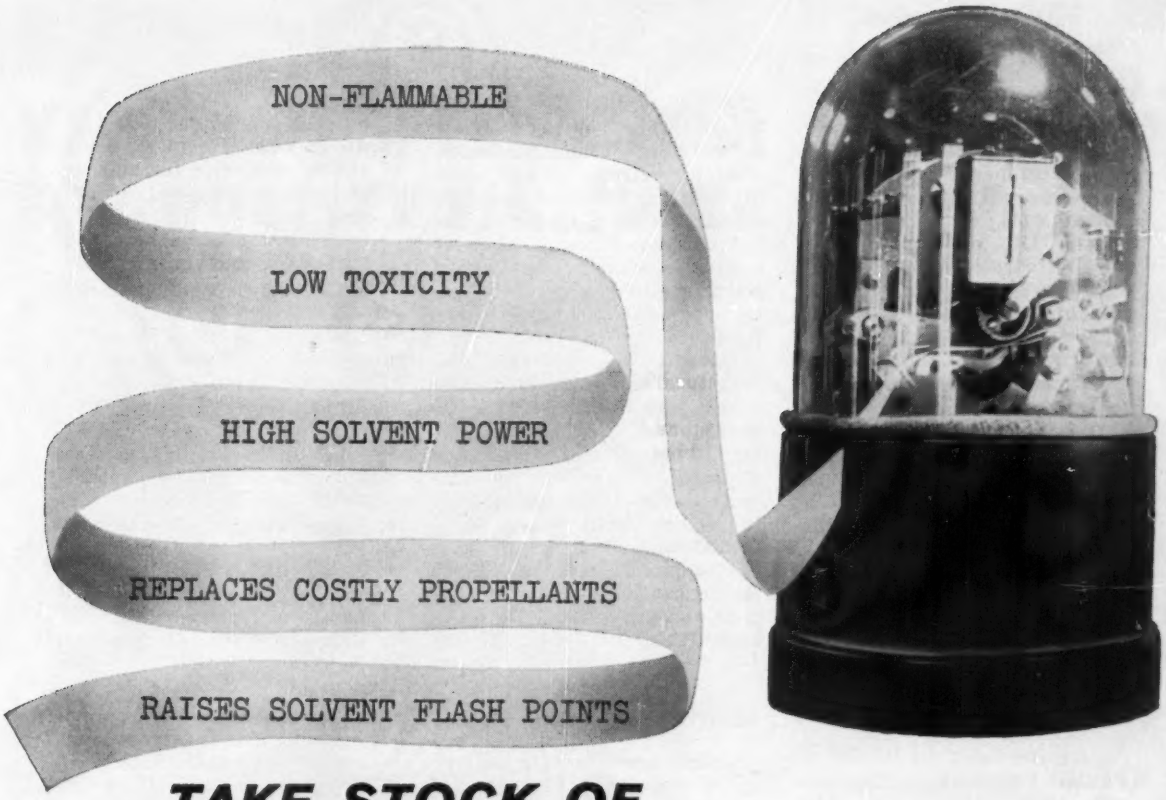
▶**New Candidate** — Firestone believes both Diene and Coral rubbers may play an important role in conserving the use of natural rubber and in minimizing the necessity of stockpiling natural rubber for wartime emergencies.—**Firestone Tire & Rubber Co., Akron, Ohio.** 74B

A number of other companies have also been at work on polybutadiene rubbers (*Chem. Eng.*, Aug. 11, 1958, p. 71). About two years ago Phillips Petroleum Co. announced preparation of elastomers of controlled structure by means of stereospecific catalysts. These materials have included linear polybutadienes ranging in configuration from over 95% cis to nearly 100% trans. A Phillips spokesman summarizes current progress for CE:

▶**Purity Problem Eased**—"Our program to date on cis-polybutadiene (about 95% cis) has reached the small pilot plant stage, and we have encountered no serious problem in this process. It is significant that the difficulties with trace impurities in the monomer that plague the producers of polyisoprene do not seem to carry over to the preparation of polybutadiene. Our pilot plant uses commercial grade butadiene directly from our Plains butadiene plant with no further purification except drying.

"Cis-polybutadiene is not 'synthetic' natural rubber since it does not consist of isoprene units. However, it has the characteristic low heat build-up of cis-polyisoprene (natural rubber) and it is superior to it in resistance to oxidation. It can be blended with natural rubber to give stocks that appear to be essentially equivalent to the 100% natural product.

▶**A Favorite**—"We think it is



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Freezing Point	—142.1°F. (—96.7°C.)
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Pounds per Gallon (20°C.)	11.07
Specific Heat of Liquid (20°C.)	0.284 cal./gm./°C.
Latent Heat of Vaporization (at B. P.)	78.7 cal./gm.
Flash Point	None
Vapor Pressure at 70°F	17.2 inches Hg vacuum (—7.6 psig)
Vapor Pressure at 120°F.	5.4 psig

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possible that cis-polybutadiene may be favored over cis-polyisoprene to extend the supply of natural rubber when natural sources prove inadequate.

"Our work on the development of polybutadienes of controlled structure has not been limited to the 95% cis product. Polybutadienes of other structures and some of the copolymers obtainable with stereospecific catalysts are proving to be extremely interesting elastomers.

"Phillips currently has no definite plans for the commercial production of cis-polybutadiene or of any of the various other polydienes of controlled structure which we have under study. We have built up a background of laboratory and pilot plant information in this entire field, however, that will permit us to move quickly in the direction of commercialization of any one of these products should it appear desirable to do so."—**Phillips Petroleum Co., Bartlesville, Okla.** **74C**

Epoxy Resins

High softening point of new 661 resin lessens blocking in shipping.

Three new solid epoxy resins are destined for use in coatings for appliances, auto body primers, cans, drums, for industrial maintenance and in glass reinforced laminates for aircraft structures, adhesives and electrical printed circuits.

Superior purity is claimed for the new resins, a characteristic which will enable processors to use the dissolved resin without filtering. Called D.E.R. 661, 664 and 667, they also have a color rating of one maximum, meaning extreme clarity compared with ratings that range as high as eight maximum for conventional products. Lowest sodium content of any epoxy resins available gives them better electrical and coating performance.

D.E.R. 661 is a low molecular weight resin for catalytically cured coatings, and can be cured at room or slightly elevated temperatures. D.E.R. 664 is useful in ester type one-component systems needing no curing agent, while 667 is catalytically cured, requiring high baking temperatures, and gives maximum flexibility and toughness.—**Dow Chemical Co., Midland, Mich.** **76A**

Modifier for Epoxies

Organophosphorus compound costs 20% less to use.

A new modifier for liquid epoxy resin systems is reported to impart a low initial viscosity, accelerate the rate of cure and maintain or improve the physical and electrical properties of the finished resins while at the same time cutting their cost by 20% and more.

An organophosphous compound called Mod-Epox, it costs 46¢/lb. in carload drum lots. This contrasts with the 80¢ to $1.25/lb. price of glycidyl ethers currently used as diluents for expoxies.

In addition to price advantage, it is said to impart better dimensional stability and chemical and water resistance than is obtainable with unmodified resins or systems using other modifiers. Hardness of Mod-Epox-cured resins is just about equivalent to that of unmodified resins.

Low initial viscosity of its formulations is reported to permit use of larger amounts of fillers, including such low cost materials as calcium carbonate, without deteriorating effect upon the finished resins.—**Monsanto Chemical Co., St. Louis, Mo.** **76B**

BRIEFS

Hafnium-free zirconium oxide and tetrachloride for nuclear and research applications are now available in tonnage quantities to users here and abroad.—**Columbia - National Corp., Cambridge, Mass.** **76C**

Improved stress resistance is created in a new series of polyolefin resins by adding branches of the proper type at proper intervals to the long, straight molecular structure of rigid polyethylene. Branches reduce tendency of the molecules to slip past each other under stress. Called Fortiflex B resins, they exhibit improved flow and processability. — **Celanese Corp. of America, New York, N. Y.** **76D**

Bifunctional aromatic, 2-aminobenzenethiol, undergoes reactions typical of the amino and mercapto groups. It is expected to find use in dyes, rubber accelerators, fungicides and bactericides. — **American Cyanamid Co., New York, N. Y.** **76E**

Phenolic resin, Plyophen 5900, has been especially designed for use in missiles and rockets. Laminated parts made from it will withstand up to 4,500 F. for brief periods, and up to 500 F. for over 100 hrs. —**Reichhold Chemicals, Inc., White Plains, N. Y.** **76F**

Gallium eutectic alloys newly available are expected to find use where reliable sealing compounds for high vacuums are desired.—**United Mineral & Chemical Corp., New York, N. Y.** **76G**

For More Information . . .

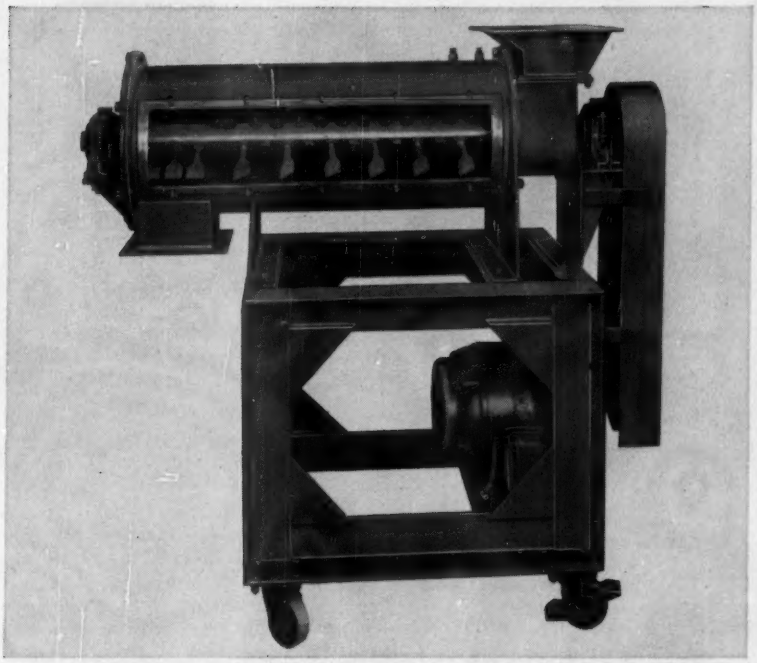
about any item in this department, circle its code number on the

Reader Service

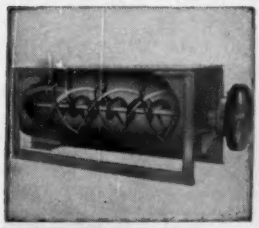
postcard (p. 171)

NEW PRODUCT NEWS

NEW HIGH SPEED MIXER FOR QUALITY FINISHING

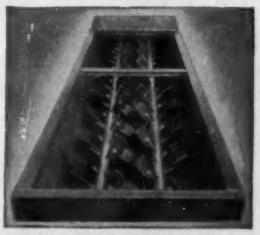


The Turbulizer produces a homogeneous mix, increases production while reducing mixing time and costs.



TRIPLE ACTION MIXER—Complete uniform blending in 2 to 7 minutes.

STRONG-SCOTT TRIPLE ACTION MIXER exposes each particle in the mixture to over 10,000 separate mixing actions per minute as it blends and folds. This produces a uniformly mixed product with 99.9% thorough distribution of minor additives.



TWIN ROTOR MIXERS—Accurate blending of liquids and dry mix at any speed.

TWIN ROTOR MIXERS are designed primarily for high percentages of liquid application to light weight ingredients, where product identity is to be maintained. A double shaft assembly with overlapping, adjustable paddles gently combine the liquids with the dry mix.

STRONG-SCOTT TURBULIZER

Provides Fast, Thorough Dispersion, Disintegration and Blending of Dry Materials, or Pastes Involving Liquids and Solids.

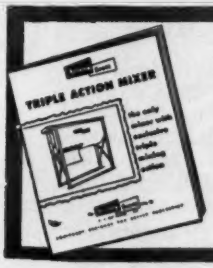
The TURBULIZER is a high speed, continuous mixer that will disintegrate and disperse fat pellets, chemical ingredients which have a tendency to ball or agglomerate, and other ingredients which can be broken by the paddles and thoroughly dispersed in the mixture. Product uniformity is accurately maintained as a result of high speed centrifugal forces created by the paddles.

It is also highly applicable where a fluffing action is desired on powdered material. Minor percentages of liquid may easily be added to dry mix with high efficiency and dispersion results.

The TURBULIZER is self cleaning and is built with sanitary seals at each end of the shaft. The interior is precision machined. Overlapping, adjustable paddles turn within a close tolerance to the chamber wall, providing a selective rate of material flow.

The TURBULIZER may be furnished in carbon or stainless steel and may be jacketed for hot water, steam or a refrigerant. Capacities will vary depending on the bulk density of the material and the degree of agglomerates encountered. Consult Strong-Scott for full details.

SEE OUR COMPLETE LINE OF EQUIPMENT IN THE 1958 CEC PAGES 1709-1712



WRITE FOR FREE COLOR BULLETIN

For complete information on the equipment shown above, write to The Strong-Scott Mfg. Co.

The Strong Scott Mfg. Co.

DEPT. CE-630

Equipment Designed for Better Processing

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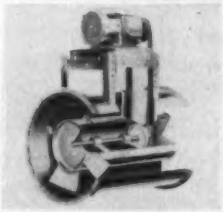
DEVELOPMENTS . . .

PROCESS EQUIPMENT

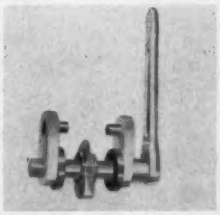
EDITED BY C. C. VAN SOYE

Latest Developments



Axial Fans

Mount directly in ducts and stacks to supply or exhaust gases. ***80C***

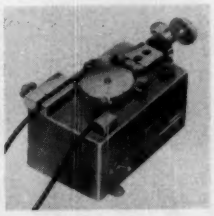


Flange Spreader

For faster, safer, more economical maintenance on pipe. ***154A***

Foamed Silica

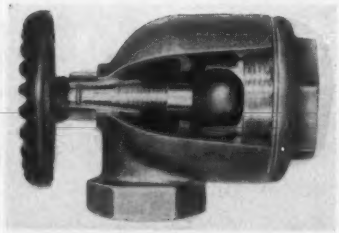
Finds application as acid-resistant, insulating material. ***155A***



Metering Pumps

Compact units precisely inject low volumes of liquids or gases. ***156A***

Page number is also Reader Service Code Number



Shut-Off Valve

Design prevents nuisance leaks, lowers maintenance.

Unique design of a new shut-off valve insures positive closure despite heavy usage. In operation, retraction of the valve stem allows fluid inlet pressure to force a neoprene ball against the beveled seat, thus stopping flow. When the valve is open, the ball floats free but remains axially aligned with its seat. Rotation of the ball causes a self-cleaning action that minimizes corrosion and collection of sediment. An O-ring seal stops stem leakage.

Cast of bronze with a machined brass stem, the valve is available in angle or in-line models for ¾- and 1-in. pipe. Working pressures to 150 psi.—**Rene Mfg. Co., Minneapolis, Minn.** 78A

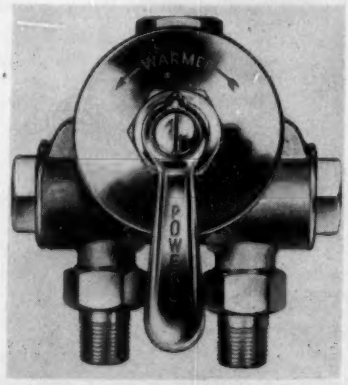
Crystallizer, Strainer

Two machines offer new processing versatility.

Originally developed for, and used by the sugar industry, two items of equipment may solve some difficult processing problems for all the CPI.

The Rolstan crystallizer and mixer coil, an item currently used in sugar mills, consists essentially of a horizontal drum containing a motor-driven rotating multipass coil. Feed liquor flows through the drum on the coil's shell side; coolant passes through the rotating tube assembly. This arrangement endows the unit with three desirable operational characteristics: uniform heat transfer, mild agitation of the crystal-bearing liquor and ease of cleaning.

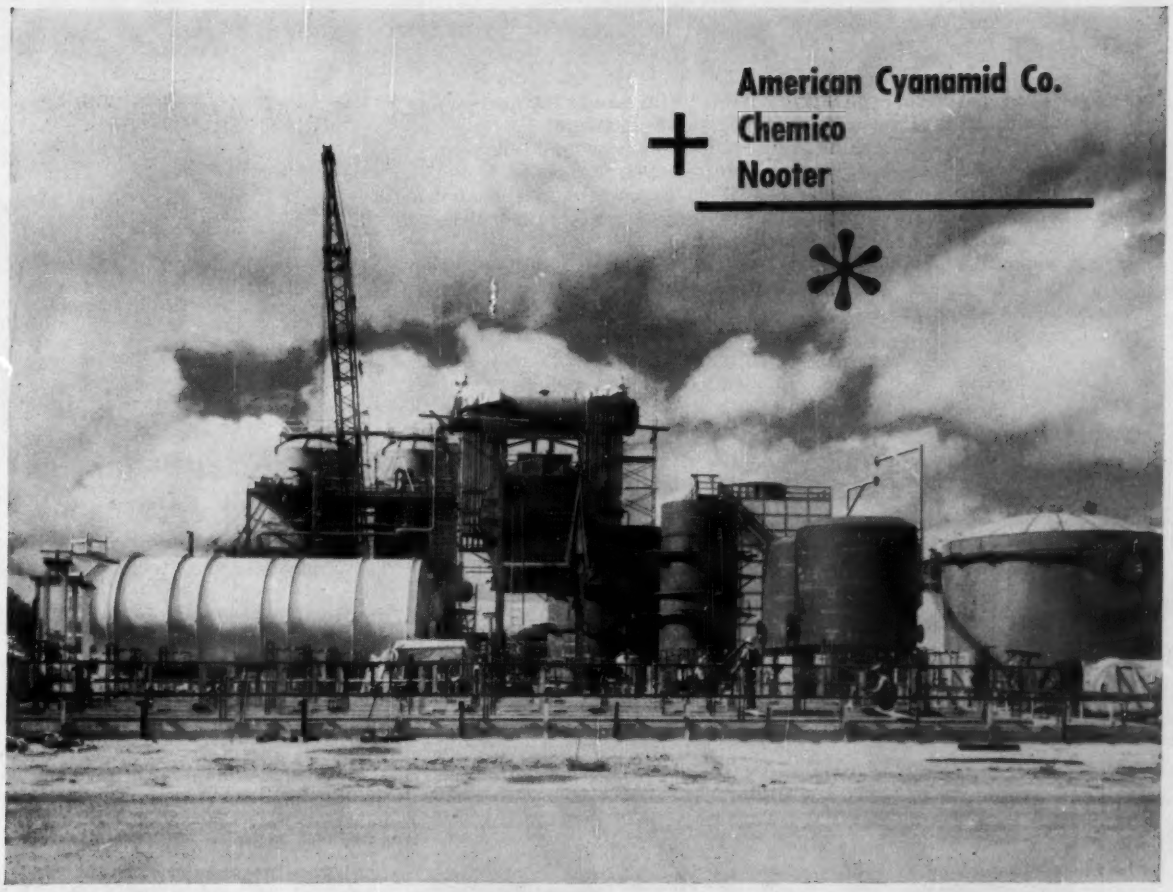
The Carter juice strainer also is novel in construction and operation. Designed for removal of bagasse particles and other insolubles from defecated juice, the unit has three major components housed within a horizontal tank: rotating fine-mesh cylindrical screen, feed-spray header and "trash" trough. Unfiltered juice sprays down from the header onto the inside of the screen which, in rotation, carries retained material to the zenith of rotation. Here, wash water sluices the trash into a sloping removal trough.—**Baeuerle & Morris, Inc., Philadelphia, Pa.** 78B



Steam-Water Mixer

Protects workers from bad scalds during wash-down.

The Style D mixer automatically maintains wash-down water at a given temperature regardless of flow changes in the water and steam supply



*they all add up to on-time performance for this triple superphosphate plant!

When American Cyanamid Company decided to expand its facilities for the manufacture of triple superphosphate, it looked to Brewster, Florida, for the plant site, and to the Chemical Construction Corporation for the designing and building of a new fertilizer plant.

It is significant that Chemico, in turn, called in the Nooter Corporation to custom fabricate and field erect all the tanks and processing vessels for the sulfuric acid facilities of this "fertilizer factory". Through past association, Chemico has learned to depend on Nooter skills for several important reasons:

(1) Years of specialized experience in the field of custom fabrication enabled Nooter to offer many time- and dollar-saving suggestions both before and during the plant installation.

(2) Nooter's extensive experience in field erection meant top assurance of on-time deliveries.

(3) The quality of Nooter workmanship is known and respected from coast to coast. This fact, plus Nooter's competitive price, made them the natural choice for the job.

This is the kind of service you can expect from every Nooter job, whatever its size or location. Why not call Nooter for your next custom fabrication, whether shop fabricated or field erected? You'll find that Nooter quality and dependable schedules are your best equipment investment.

Write for: CATALOG #258
"Field Erected Processing Equipment"

NOOTER CORPORATION

"Since 1896"

Steel and Alloy Plate Fabricators and Erectors..."Boilermakers"

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lines. In operation, a floating piston within the mixer controls and equalizes both steam and water flows before they enter the mixing chamber.

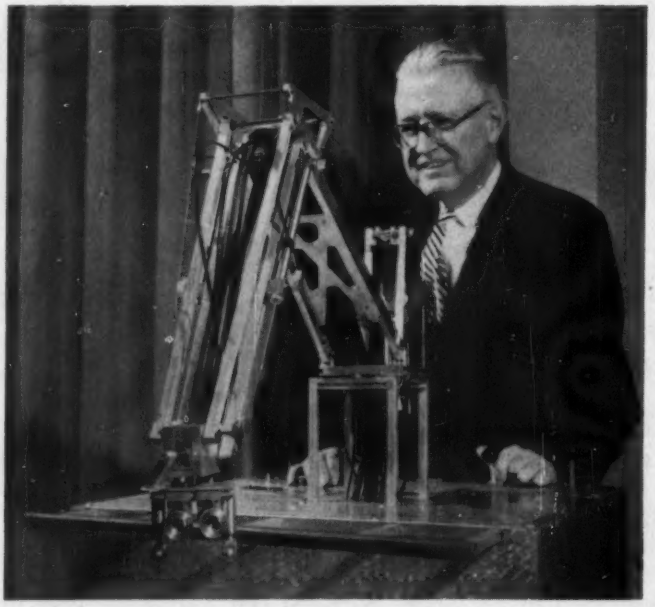
The unit delivers up to 14 gpm. of water at temperatures to a maximum of 200 F. Temperature and flow are interdependent.—**Powers Regulator Co., Skokie, Ill.** 78C

Heating Modules

Infrared units stack into any heating layout.

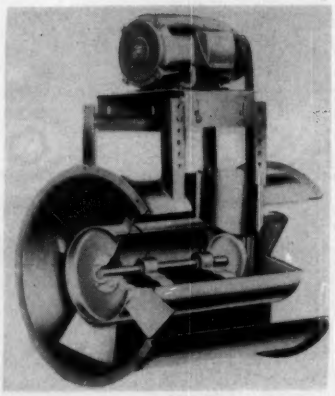
Designed for do-it-yourself arrangement into a wide variety of oven configurations, a new line of infrared heating modules features immediate, even heat and minimum maintenance requirements. Radiation from the 1,500 F. module face heats all material surfaces, regardless of color.

Each heating module consists of a sheet-metal shell, resistance-wire heating element, a ceramic diffusion face, and alternate layers of high-temperature batt and reflective insulation. Other modules have a reflective face and no heating element. Dimensions of all modules are 24 x 24 x 6 in. Available with 1-, 2- and 3-kw. outputs. — **Infrared Systems, Pompton Lakes, N. J.** 80A



Pantograph-Like Tower Speeds Tanker Turn-Around

A new hydraulically operated rig, similar to the model shown here, will soon convey oil hose from dockside to ship's manifold at Asiatic Petroleum Co.'s Bayonne, N. J. terminal. With only one man at its controls, the rig can steer two 12-in. oil lines directly to the manifold in 3 min.; presently, an 8 or 10-man crew frequently consumes 1½-2 hr. for the same operation. The U. S. Rubber Co., which developed the rig, is offering its plans to the oil industry without charge. Estimated cost of each 22-ton unit is about $40,000, not including hose.—U.S. Rubber Co., 1230 Avenue of Americas, New York 20, N. Y. 80B



Axial-Flow Fans

New units mount directly in ducts and stacks.

Compact in design, a new line of motorized fans comes equipped with inlet and outlet flanges for direct mounting in ductwork or stacks. If required, corrosion-resistant coatings or special materials of construction are available to permit handling of corrosive or explosive atmospheres.

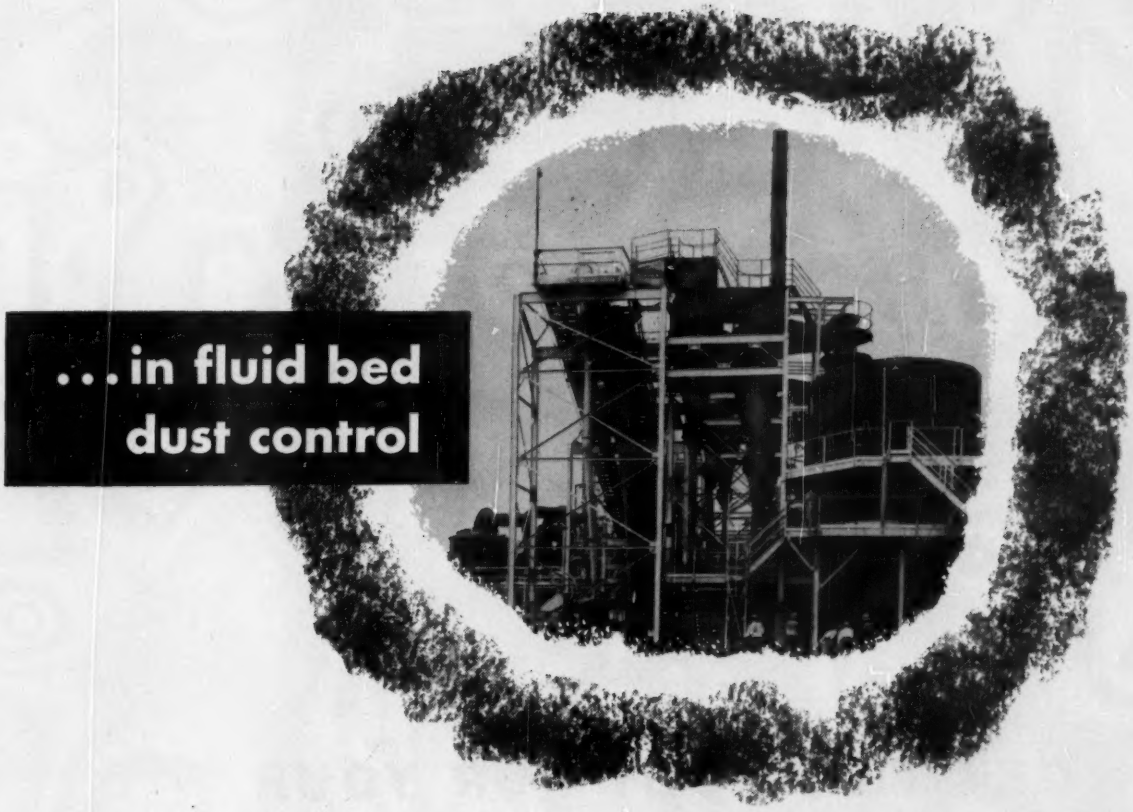
According to the manufacturer, the heavy-gage, steel-welded construction assures durability and long-life operation in high-temperature service. In seven sizes for ducts and stacks from 18 to 42 in. diameter, the line has capacity ratings from 2,410 to 36,700 cfm.—**Westinghouse Sturtevant Div., Boston, Mass.** 80C

Chlorine Dioxide Plant

Packaged units tailored to buyer's needs.

Pre-engineered packaged plants for on-site generation of chlorine dioxide are now available in glass. Based on either the Solvay or Olin-Mathieson process, the packages feature glassed-steel construction in all potential trouble areas, such as reactors, columns, storage vessels, piping and even pumps. Experience has proven glassed steel to be ideal for this service—it has the necessary corrosion resistance, rugged-

These significant equipment developments are continued on page 154.



DUCLONES® provide high recovery efficiency, insure continuous operation

DUCLONE high efficiency cyclone dust collectors are designed and constructed to take unusual service conditions in stride. That's why they have gained wide acceptance in fluid bed processes, such as the one illustrated for pyrite roasting to produce sulfur dioxide for manufacture of sulfuric acid. A special refractory lined primary Duclone and stainless steel secondary Duclones were supplied by Ducon to insure continuous operation under the inherent high temperature and corrosive conditions of the process.

High efficiency Duclones are available in a wide range of capacities and in multiple units and special materials to meet a wide variety of dry dust control applications.

Send for Bulletin C-958.

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GET THE MOST FOR YOUR

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...with Nicholson steam traps

You get top operating temperature per dollar of fuel consumption . . . when you use the Nicholson steam trap. This trap purges all air and non-condensibles from pipes and equipment *continuously* . . . not just at warm-up time. Your boiler doesn't have to operate at top capacity —all the time—to obtain top steam temperature where and when you need it.

Make full use of your BTU dollar, with Nicholson traps. They have only one moving part . . . a valve that operates on just a few degrees of temperature differential.

In your steam generation, and in your steam utilization . . . Nicholson traps will save you money. You can try one . . . without obligation! W. H. Nicholson and Company, 12 Oregon St., Wilkes-Barre, Pa. Sales and Engineering Offices in 98 principal cities.

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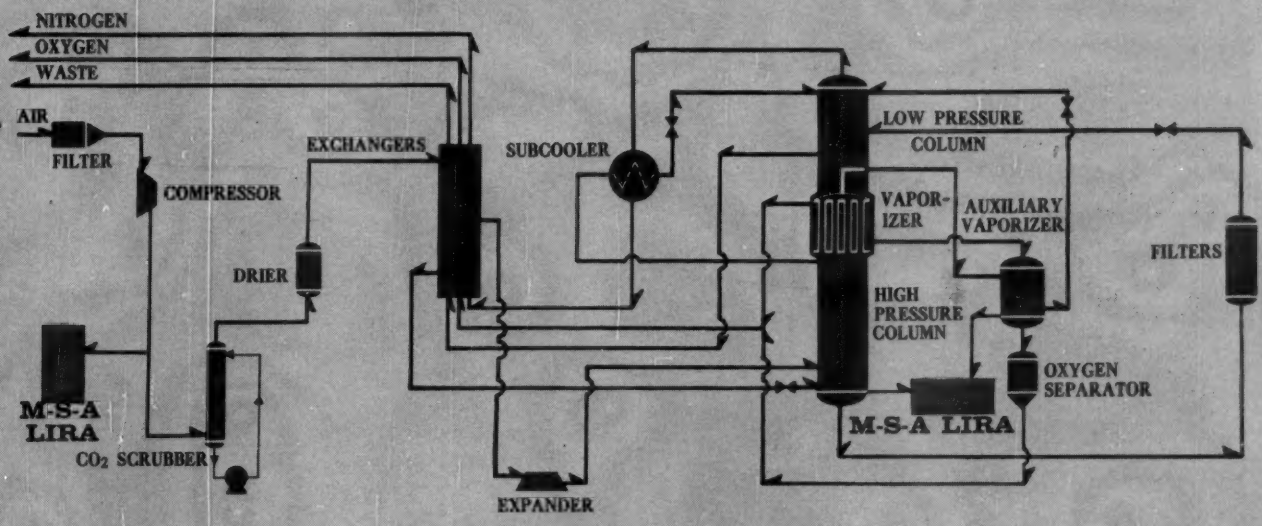

Flow diagram of a standard medium pressure air separation cycle employing M-S-A LIRA Analyzers for plant safety.

Explosion-proof Model 200 has a tamper-proof lock, and all controls are easily accessible through the explosion-proof enclosure.

M-S-A® LIRA Analyzers can protect your oxygen plant

You can keep strict tabs on dangerous accumulations of acetylene and total hydrocarbons by continuously monitoring the air stream and the liquid pool with M-S-A LIRA Infra-Red Analyzers

Safe operation of air separation equipment demands continuous monitoring of acetylene. This troublesome hydrocarbon contaminant has very low solubility and is highly reactive. That's why a number of plants throughout the country are installing M-S-A LIRA Infra-Red Analyzers for explosion prevention.

These versatile instruments measure acetylene and total hydrocarbons in the air intake streams, as well as in the liquid pool itself. Model 100 LIRA Analyzers have been sensitized for full scale ranges of 1.0 and 2.0 ppm acetylene. Thus, it is possible to measure concentrations as low as 0.02 ppm acetylene. With this sensitivity it is also possible to continuously monitor the air stream and sound an alarm in the event a large concentration is suddenly drawn into the plant or, if there is a gradual build-up.

Model 200 Analyzers have been provided to measure the total hydrocarbons present in the air stream as well as the liquid oxygen pool. By means of these instruments, operators are advised at all times of the degree of contamination in the system, and can take steps to prevent development of explosive mixtures.

An M-S-A Instrument Specialist will be happy to discuss your product contamination problems. Write us for helpful literature.

INSTRUMENT DIVISION

Mine Safety Appliances Company
Pittsburgh 8, Pennsylvania

"De Laval hermetic centrifuges absolutely eliminate process frothing, oxidation or emulsification."

Fred Wheelwright, De Laval Separator Co.

De Laval Hermetic Centrifuges make possible the fast, continuous processing of liquids otherwise incompatible with centrifugal action. With many of these liquids, processing becomes for the first time both efficient and economical.

It's all a matter of pressure. By maintaining constant pressure (up to 100 psi) from inlet to outlets, the liquids being processed are maintained in a closed system, never have a chance to foam, oxidize or emulsify. There is absolutely no contact with air so product purity is protected in a manner impossible in other methods of clarification and separation.

PRESSURE-SEALED

The De Laval Hermetic Centrifuge is basically the same as the famous De Laval Disc-Type Constant-Efficiency Centrifuge. The important difference is the presence of the special De Laval long-life seals at inlet and outlets. They maintain positive pressure throughout the centrifuging process.

The disc bowl is easily removed for cleaning when necessary, but it is possible in many cases to clean the bowl in-place. This is accomplished simply by feeding water, a detergent solution or a solvent into the outlet and back flushing the discs and bowl walls. With this system, there is no need for stopping and dismantling the machine. Stainless steel discs are standard equipment on all Hermetics.

ESSENTIAL OILS TO SOAPSTOCKS

These are only two of the many diverse materials now benefiting from centrifugal processing with the De Laval Hermetic. Any liquid that is viscous, inflammable or that must be kept free from contact with air may well be processed more efficiently and economically with a De Laval Hermetic. We have three different size conventional solid-bowl Hermetic machines which cover a wide range of applications. And recently we've developed a Hermetic NOZZLE-TYPE centrifuge. It's such a new development we're not sure of *all* the processes where it may be applied, but it shows great promise in several fields. We'd welcome your inquiries.

Operating as a separator, the Hermetic features a special back-pressure control valve on the light-liquid discharge permitting instant adjustments with absolute accuracy for change of relative gravity of light and heavy phases without stopping the machine.

NAME THE LIQUID

If you'd care to send us your process data and samples of your material, we'll be glad to have our engineering staff run pilot plant studies and send you their objective recommendations. They're guaranteed objective because we're the only company that makes Hermetic Centrifuges. If you'd like, your own technical staff can work with De Laval on these tests. No obligation, of course.

Booklets S. A969 and S. A983 give further specifications and operating details. Or to have one of the De Laval Sales Engineers call on you, just drop us a line on your letterhead.

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SEPARATOR COMPANY

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JENKINS

O.S.&Y. U-BOLT GATE

MADE BETTER THAN NEED BE . . .

Costs Less to Use

YOU PAY NO MORE for the extra quality you see in every part of a Jenkins Outside Screw & Yoke U-Bolt Gate valve. Yet longer life and reduced maintenance is bound to result from the extra ruggedness, the precision manufacture and unique design features which Jenkins puts into these popular, general utility valves.

Choose the Outside Screw & Yoke pattern for services where spindle threads must be kept out of the destructive effects of fluids in the line; where spindle threads must be cleaned and lubricated regularly or where a rising spindle is needed to indicate wedge position.

Choose JENKINS, whether O.S. & Y. or Inside Screw pattern, for valves built to save maintenance dollars.

WIDE RANGE OF JENKINS U-BOLT GATES

GET FOLDER NO. 207 which describes Inside Screw and O.S. & Y. patterns . . . Iron Body with Bronze or Stainless Steel Mounting . . . All-Iron and Ni-Resist with type 316 Stainless Steel trim. Ask your local Jenkins Distributor or write Jenkins Bros., 100 Park Avenue, New York 17.

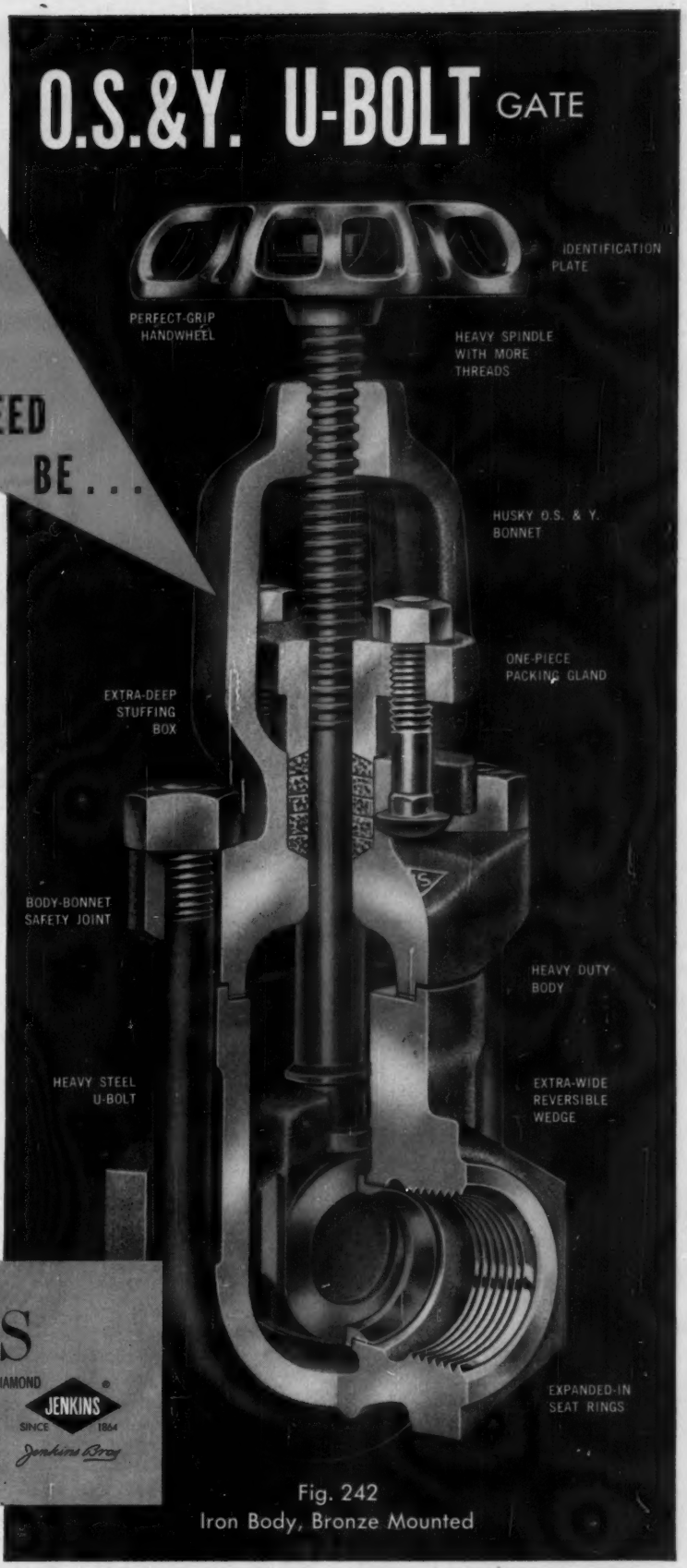


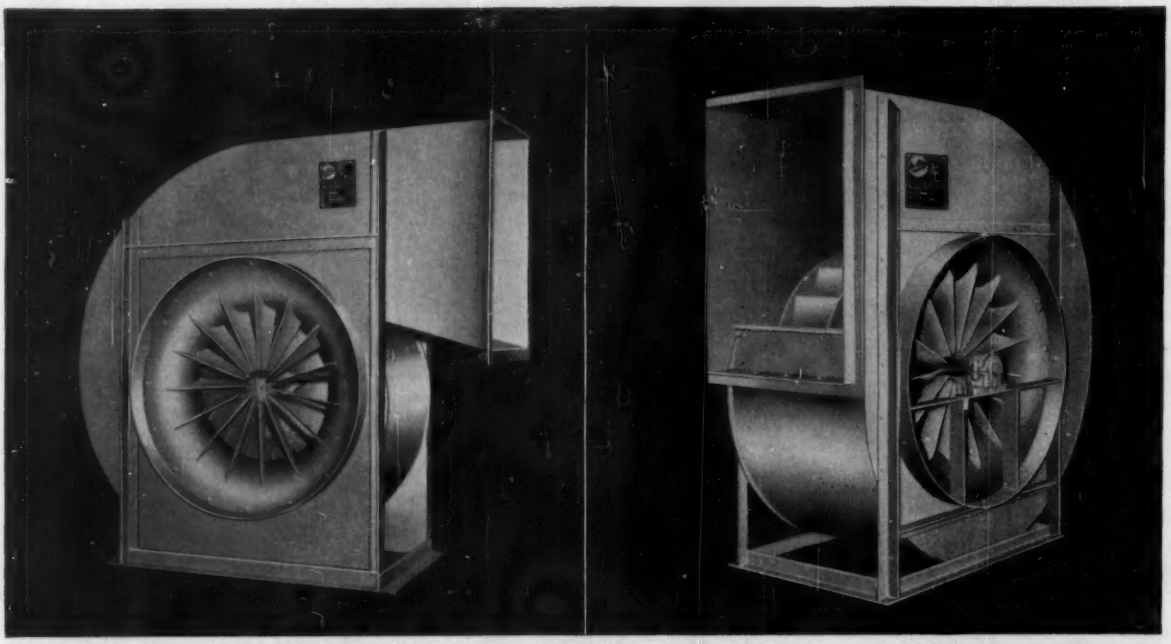
Fig. 242
Iron Body, Bronze Mounted

JENKINS VALVES

LOOK FOR THE JENKINS DIAMOND

JENKINS SINCE 1864 Jenkins Bros

Sold Through Leading Distributors Everywhere



For Classes III-IV (High Pressures) The "Buffalo" Type "BLH" Fan

For Classes I-II (Moderate Pressures) The "Buffalo" Type "BL" Fan

FOR THE BEST ENGINEERED JOBS, SPECIFY BUFFALO "JOB-SUITED" FANS

For central system applications you don't have to accept a "compromise fan", loosely designed to cover any and all pressure requirements. "Buffalo" builds *two* fans, each engineered to fulfill specific pressure requirements to the highest possible degree. Brief engineering details on these "no compromise" "Buffalo" Fans are given below.

The "Buffalo" Type "BLH" Fan is recognized by engineers and contractors alike for its outstanding performance in Classes III and IV service. The "BLH" maintains an extremely high mechanical efficiency of 86% over a broad operating range. The smooth inlet bell with matching shroud, directional inlet vanes, backward-curved blades and divergent outlet all contribute to quiet operation and minimum turbulence. "Buffalo" engineering features, plus husky construction, add up to an efficient high pressure fan that will deliver long, faithful, maintenance-free service. When you plan a conduit system or other Class III-IV installation, be sure to specify the "BLH". Call in your "Buffalo" representative or write for Bulletin F-200.

The "Buffalo" Type "BL" Fan has gained wide acceptance for peak performance in major Class I and II installations throughout the country. Non-overloading, the "BL" provides quiet, stable, output from free delivery to shutoff. The smoothly-curved inlet bell, with directional guide vanes and matching shroud, assures minimum turbulence. Highest efficiency is attained by the streamlined wheel with backward curved blades, factory tested and balanced to hold vibration to an absolute minimum. The correctly shaped scroll of the wheel-contoured housing further contributes to smooth air flow. For full information on the rugged, reliable "BL" Fan for Class I and II conditions, contact your "Buffalo" engineering representative. Or, write direct for Bulletin F-104.

You get a ***value dividend*** with the "Q" Factor — the built-in QUALITY that provides trouble-free satisfaction and long life in ***every*** "Buffalo" product.

BUFFALO FORGE COMPANY • Buffalo, New York

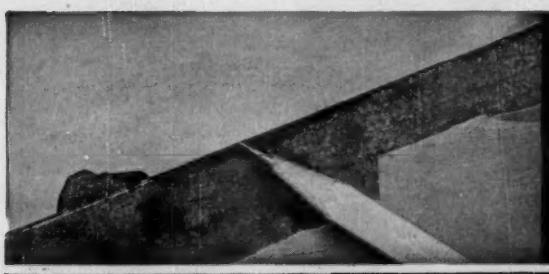
Buffalo Pumps Division, Buffalo, New York

Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

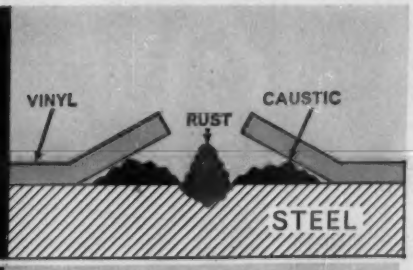
VENTILATING AIR CLEANING AIR TEMPERING INDUCED DRAFT EXHAUSTING FORCED DRAFT COOLING HEATING PRESSURE BLOWING

PUZZLED ABOUT PRIMERS?

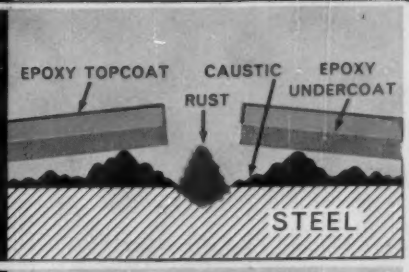
Here are tests you can duplicate

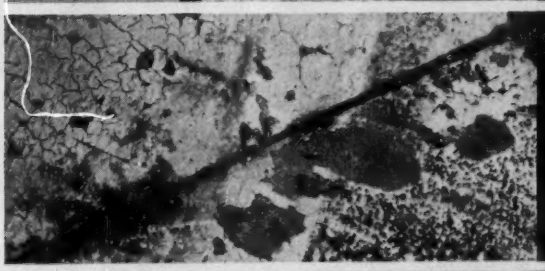


TEST 1—One coat of self-priming vinyl. Coating breaks away (L) due to severe undercutting (R), exposing metal to progressive corrosion.

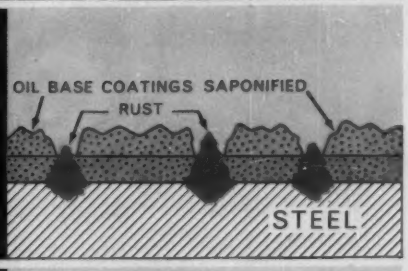


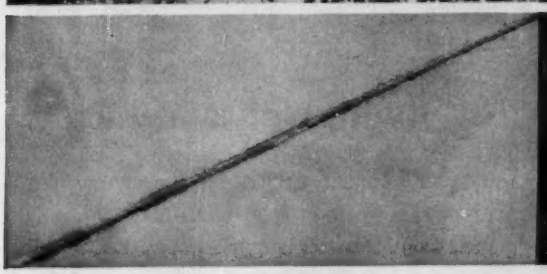
TEST 2—Epoxy primer, epoxy topcoat. Coating lifts off in single sheet (L) as adhesion fails (R), exposing entire surface to corrosion.



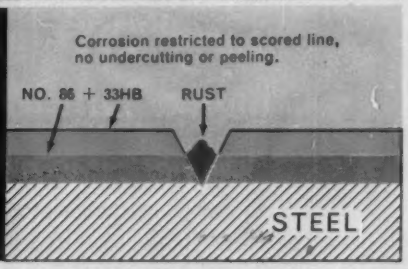


TEST 3—Oil primer, oil topcoat. Both coats fail completely (L) as underfilm caustic reacts on their oils to form soaps (R).





TEST 4—Amercoat's No. 86 inhibitive primer and No. 33HB vinyl topcoat. Corrosion restricted to scored line (L), no undercutting or peeling (R).



The purpose of these accelerated tests is to show what happens when various types of coatings are exposed to a typical corrosive environment. Four clean steel panels, free from mill scale and rust, were coated with different combinations of primers and topcoats. Each was scribed to bare metal and immersed in salt water in the presence of free oxygen, for two weeks.

As caustic deposits formed over cathodic areas of the steel in tests 1, 2 and 3, failure occurred in three ways. The vinyl, though not directly attacked, was undercut as caustic spread beneath the film and destroyed adhesion. The epoxy coating, known for critical adhesion to smooth metal, proved impervious to caustic attack. It was, however, lifted in its entirety as moisture spread beneath the surface. The entire oil paint film was quickly penetrated by the salt solution, creating widespread corrosion and caustic formation. The caustic then reacted with the oil to saponify the film.

In the fourth test the corrosion was limited to the score mark. Reason: Amercoat No. 86 Primer resists undercutting and adheres tenaciously, inhibiting electrolytic corrosive action.

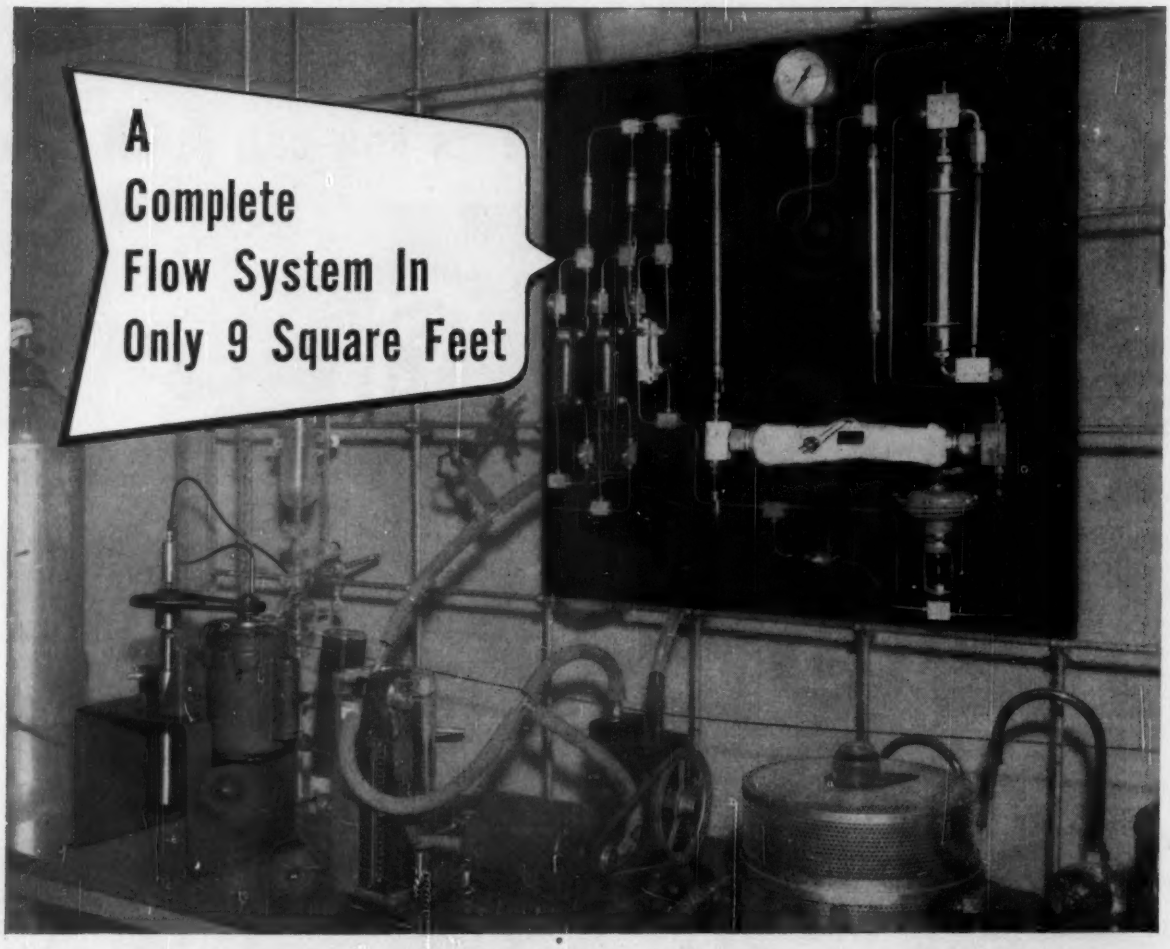
The conclusions are clear. To provide long term protection in corrosive service, start with Amercoat No. 86 Primer, which provides a sound and lasting base for quality topcoats such as Amercoat No. 33HB.

Write today for complete data on Amercoat No. 86, and have the details on hand when planning your next important coating job.

Amercoat CORPORATION

109 Dept. AZ

4809 Firestone Blvd., South Gate, Calif.



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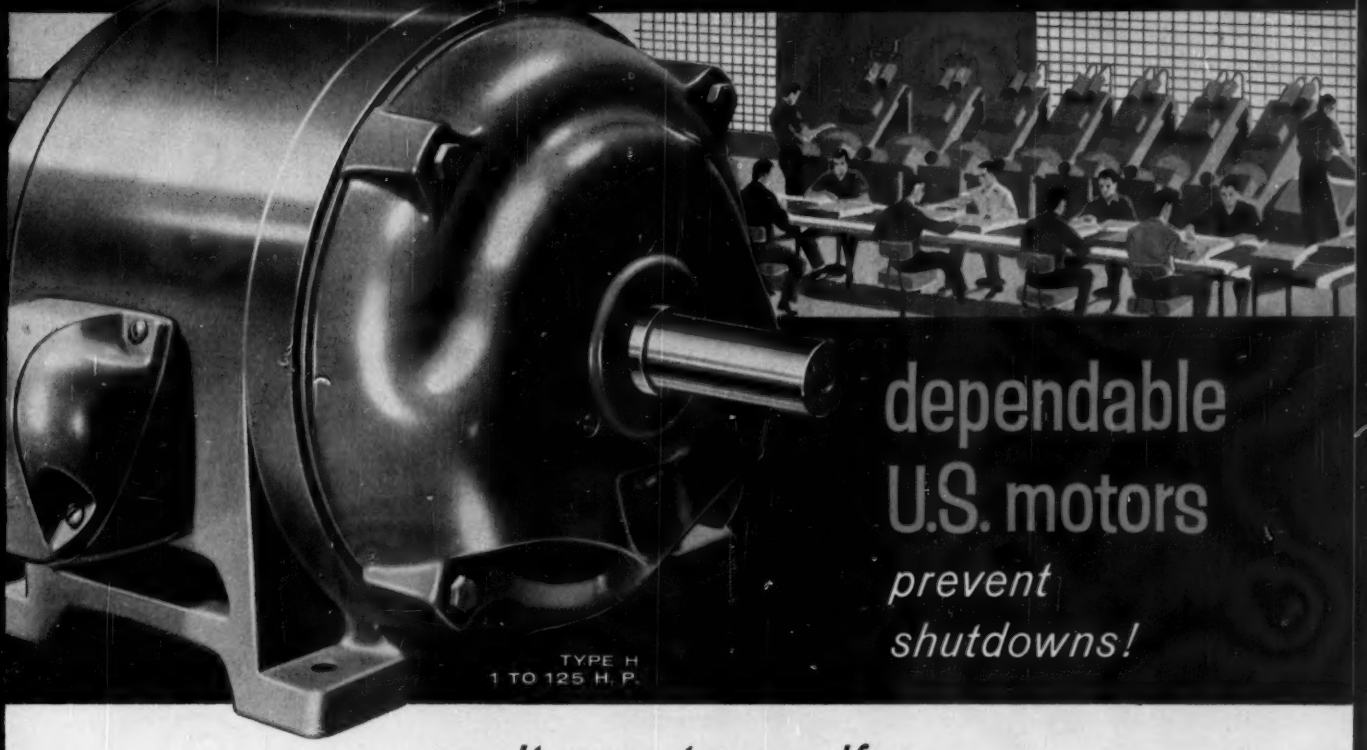

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A processed carbon-base filteraid...the first complete-new type of filteraid developed in the past 20 years.

Characteristics—Physically and chemically stable. Practically unaffected even by boiling caustic. 30 minute test in 50% sodium hydroxide at 125°F. showed no silicon solubility.

Performance—Clarity of filtrate excellent. Flowrates comparable to those obtained with many grades of diatomite filteraids, due to low density and high porosity of the Nerofil filter cake.

Special Advantages—Filter cake is combustible, an advantage in metals values recovery. Nerofil does not have the high temperature breakdown of cellulosic filteraids, nor the silicon solubility of diatomite.

History of Use—After pilot tests, Nerofil has been adopted by, and is being used by, firms engaged in caustic production, sulfur production, textile mercerizing, metal plating, metallurgical work, the filtration of lignosulfonate liquors and other 'difficult' solutions.

The Nerofil Bulletin provides more complete information. Just fill out the coupon for your copy.

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Great Lakes Carbon Corporation
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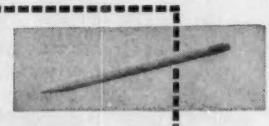

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Important Special Note

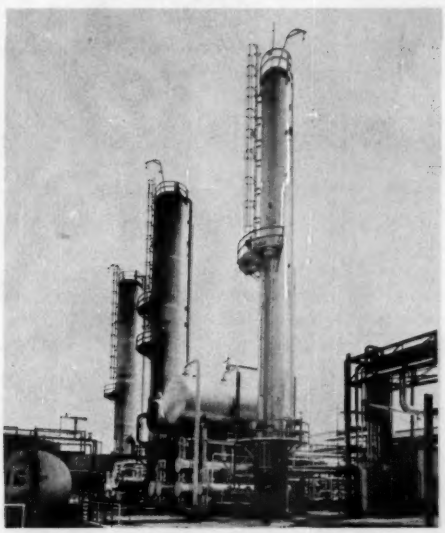
- The chemical and physical stability of Nerofil, its tremendous surface area and other properties, give Nerofil definite advantages as a filler for resins, cements, etc., as a catalyst carrier, in foundry use, and in other applications.

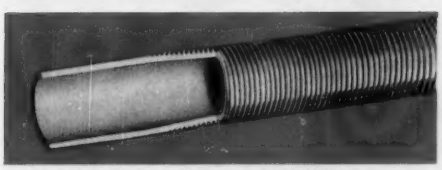
WOLVERINE
TUBE
Items of Interest to the Processing Industry

PUBLISHED BY WOLVERINE TUBE DIVISION

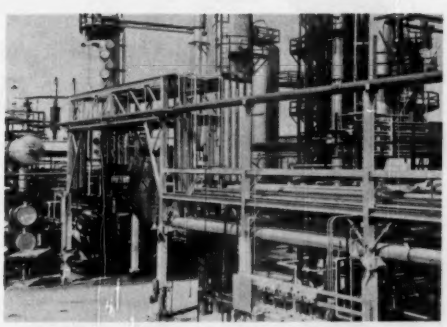
How Wolverine Trufin® Type S/T Saves Time and Money for Aurora Gasoline Company

BY ERNEST DODD





WOLVERINE TRUFIN TYPE S/T



In the Michigan refineries of Aurora Gasoline Company, Wolverine Trufin Type S/T—the integrally finned tube for shell and tube heat exchangers —is helping Aurora boost capacity and increase on-stream time by reducing costly shut downs for cleaning. Just take a look at the following examples:

EXAMPLE 1

A Trufin-tubed naphtha condenser still on stream after five continuous years of operation without downtime for cleaning on the shell side. In addition this unit has maintained throughput at a level 70% higher than the plain tube unit it replaced.

EXAMPLE 2

Five Trufin-tubed heat exchangers used in a gas concentration unit have been on stream continuously for more than two years without requiring shell side cleaning.

EXAMPLE 3

Four Trufin-tubed heat exchangers used in the catalytic cracking unit's condensing-subcooling service are still going strong after three years of continuous service without shutdown for cleaning on the shell side.

Small wonder indeed that Aurora engineers have placed their stamp of approval on Wolverine Trufin Type S/T heat exchanger tube. In addition to the benefits described above, Wolverine Trufin, because of its extended surface, transfers more BTU's per foot of tube — **making possible substantial savings in direct tube costs.**

For your heat exchanger and condenser tube needs why not follow the lead of Aurora Gasoline Company—specify Wolverine Trufin Type S/T—experience for yourself the increased efficiency and savings this integrally finned tubing will bring your way.

GET VALUABLE BOOK FREE

Detailed breakdowns in cost differentials between prime surface and integrally finned condenser tubes are graphically explained in Wolverine's new "Design and Cost Comparison of Heat Exchangers" book. Write for your free copy—TODAY!

Wolverine Trufin is available in Canada through the Unifin Tube Division, London, Ontario.

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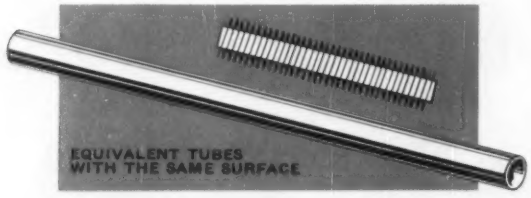
Manufacturers of Quality-Controlled Tubing and Extruded Aluminum Shapes

FACTS YOU SHOULD KNOW ABOUT WOLVERINE TRUFIN® TYPE S/T

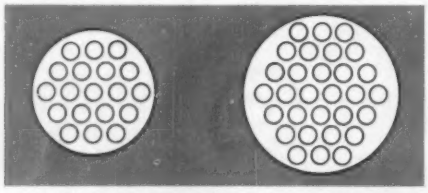
In modern heat transfer applications engineers are obtaining new standards of efficiency through the use of extended surface heat exchanger tube. Such a tube is Wolverine Trufin Type S/T—the original integrally finned tube—developed and pioneered by Wolverine Tube. Listed below are some of the time and money-saving benefits made possible through the use of this exclusive Wolverine product.



Trufin is an extended surface tube—with fins extruded right from the tube wall—it has more than 2½ times the outside area of plain tube. Less tube is required because Trufin transfers more BTU's per foot of tube.

Fewer tubes mean smaller shells, tube sheets, baffles, etc. This means greater savings in materials required.

Fewer tubes mean fewer holes to drill—less rolling-in operations. Direct result: substantial savings in labor costs.

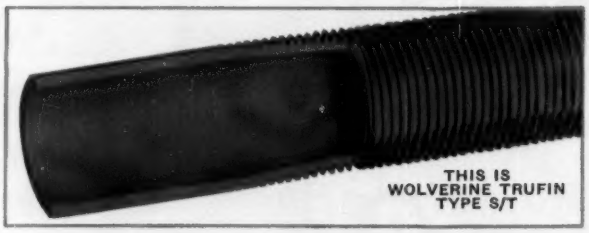


FEWER TUBES MEANS SMALLER SHELLS

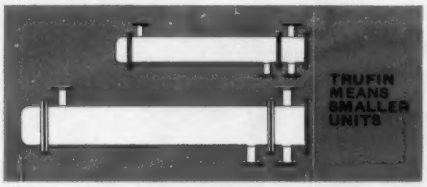
To transfer a given heat load—when Trufin is used—much less weight of overall tube metal is required. This is a real saving when expensive alloys are necessary. This is of greatest importance when alloys are in short supply, as a given amount of metal in Trufin transfers much greater heat loads.

Lighter units using less structural support can be designed because of the material savings made possible by Trufin. This is vital when units are to be super-structure mounted.

Maintenance costs are reduced. Costs of replacement tubes are slashed; fewer tubes result in less cleaning time, longer on stream time. Actual operating data proves Wolverine Trufin withstands fouling for longer periods than prime surface tube. This increases intervals between "turnarounds".



Smaller, lighter units result in easier handling and lower shipping charges.



Where space is at a premium — as in replacement units — Trufin-tubed bundles will increase capacity with the same number of tubes.

These are but a few of Wolverine Trufin's many advantages. For more complete information write for your copy of the Trufin Catalog. Do it TODAY!

☆ ☆ ☆

NOW! BOND-RESISTANCE TESTING FOR BI-METAL TUBE

A new Wolverine Heat Transfer Tester has been developed which accurately measures **bond-resistance** of Wolverine Trufin Type L/C and other bi-metal tubes.

Exhaustive tests during manufacture have shown bond resistances of Type L/C to be negligible. This is another step by Wolverine to insure your receiving the highest tubular quality.

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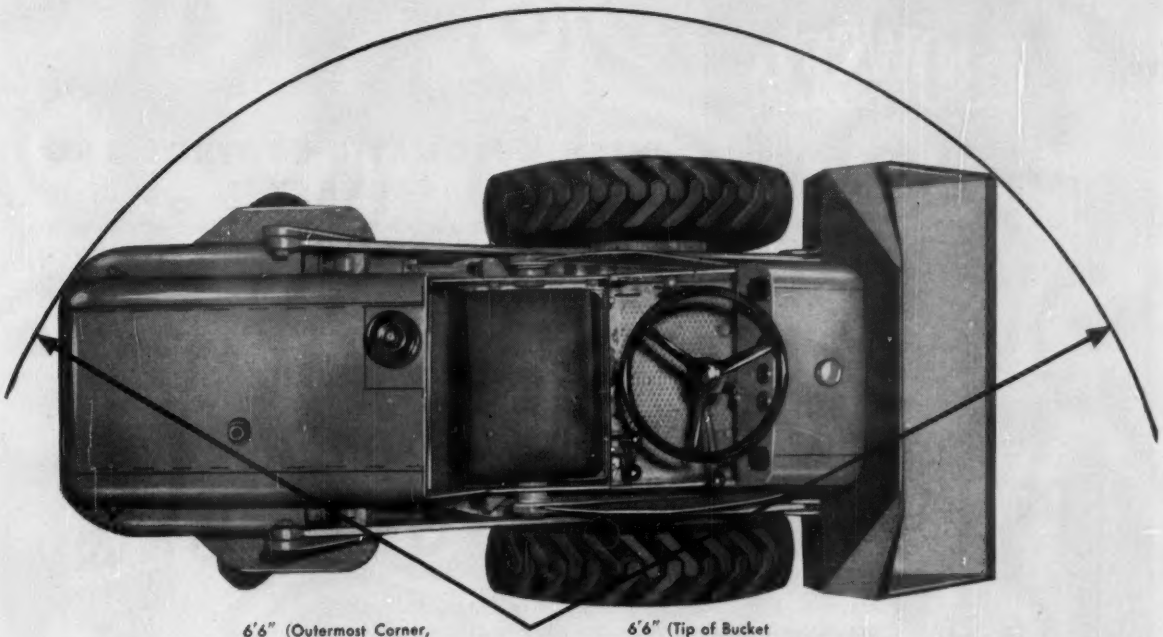

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with this short-turning, power-steered

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Here is a loader your operator can really "wheel" through narrow aisles and doorways, around columns and posts, into and out of boxcars.

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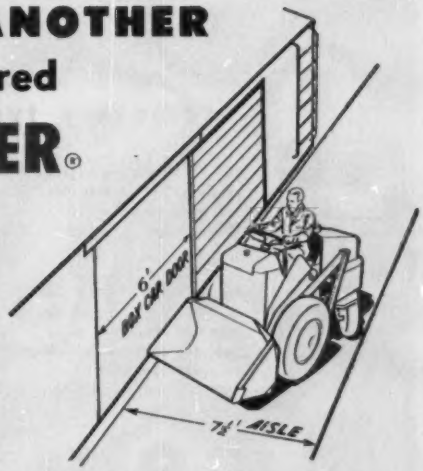

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SPEEDS:	2 forward, to 7 mph 2 reverse, to 14 mph
WEIGHT:	gasoline, 6,100 lb; diesel, 6,500 lb

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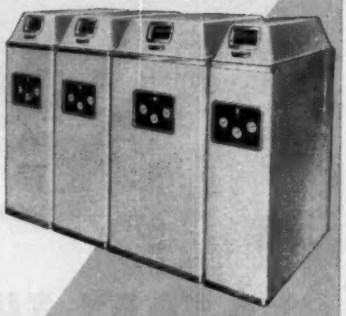

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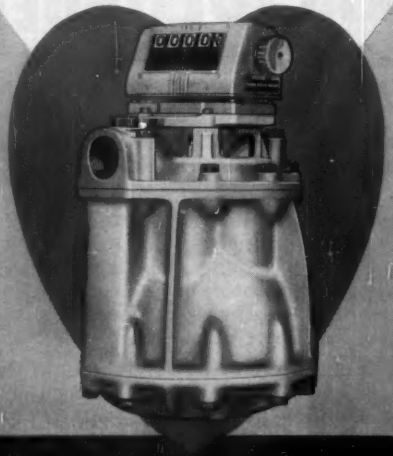
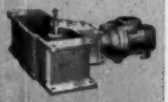
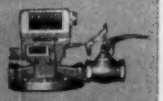




MODEL F . . . relays voltage signal to a remote flow indicator or controller permitting remote observation and control of the flow rate.



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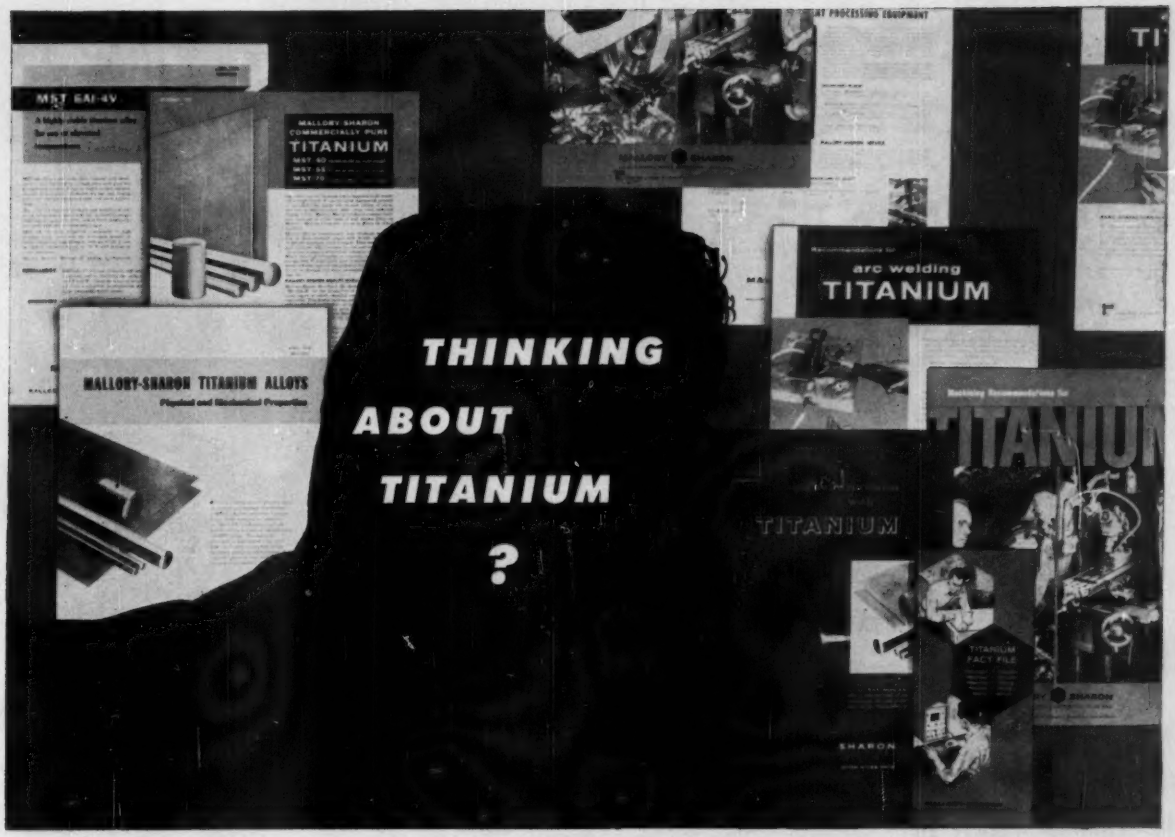

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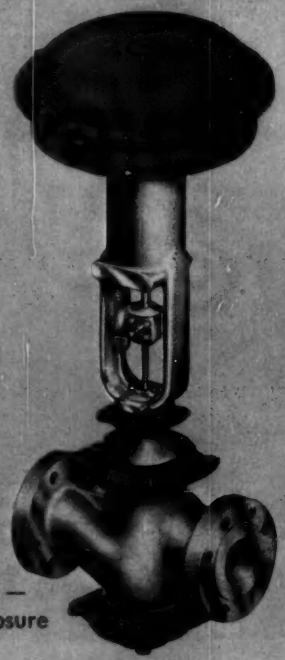
1. High Quality Product . . . The BS&B Super 70 Diaphragm Control Valve has high efficiency and stability. In addition to thousands of hydraulic flow tests performed in the laboratory, analysis of operating data gathered from Super 70's on stream in customer plants substantiate their excellent performance.

2. Application Engineering . . . Today's complex processing problems require detailed analysis to determine proper instrumentation and control applications . . . accurate control valve sizing. This is a regular service to Super 70 customers.

3. Start-up Assistance . . . After helping customers select the right valve for a specific job, BS&B follows thru by assisting at plant start-up time.

4. Time-saving Scheduled Maintenance . . . With the patented clamp ring—float ring closure, valve maintenance can be done in a fraction of the time required by conventional type valves . . . an economic must in future valve specifications.



Clamp Ring — Float Ring Closure

Flanged — Gasket Closure

BS&B Super 70 Valves are available in either clamp ring—float ring, sealed bonnet or flanged-gasketed body closures. Whichever type you choose, when they're "on stream" you'll *know* that they're exactly right for the job.

Call your nearest BS&B office or representative now to discuss your present and future valve requirements. Or if you prefer, write for detailed information.

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U.S.I. CHEMICAL NEWS

August ★ A Series for Chemists and Executives of the Solvents and Chemical Consuming Industries ★ 1958

Historical Study Indicates That Chemist Creates Most Between Ages 30 and 34

A recent study of 2,500 of the world's ablest chemists, now deceased, reveals that collectively these men did most of their important creative work between the ages of 30 and 34. Dr. Harvey C. Lehman of Ohio University, in reporting his findings in the May issue of Science magazine, says "The more brilliant the chemist, the earlier the age at which he gives genuine indications of his future greatness." " . . . after he has passed his thirties, the production rate for the most brilliant chemist's extremely important creative work tends to fall off both earlier and more rapidly than does the production rate for his own less brilliant output."

Dr. Lehman's data is drawn from 44 histories of chemistry written by German, French, American, English and Italian authors.

Plan ACS Subdivision of Organometallic Chemistry

At the American Chemical Society meeting in San Francisco this past April, the Division of Inorganic Chemistry proposed that a Subdivision of Organometallic Chemistry be set up. Action was deferred due to the newness of the Division itself, but interest continues high and indications are that the Subdivision will be formed within the next few years.

In the meantime, a day-long organometallic symposium will be sponsored by the Cincinnati ACS section on October 29, and a second Symposium on Organometallic Chemistry has been planned for the April 1959 ACS Meeting in Boston. It is felt that the field is growing rapidly enough to warrant *consistent* presentation of papers on organometallics — compounds having metal to carbon bonds.

Probably the oldest and best known organometallic compounds are the Grignard rea-

MORE

Glass Fibers Improve Compression Properties Of Polyurethane Foams

Studies now being conducted by a glass fiber producer and a supplier of urethane foam raw materials indicate that addition of 5% by weight of fiber to foam increases compression set, compressive strength and resilience. Also, per cent elongation is reduced — all without affecting density, porosity or resistance to humidity aging.

In these experiments, polyester-type urethane foams have been combined with glass fibers of various sizes to give varying results. It has been found that in cushioning, for example, ⅛-inch fibers eliminate "plateau" and cut hysteresis loss, while increasing compressive strength from 0.46 to 0.68 psi. For shock absorbers, 1/32-inch fibers give high hysteresis loss, high compressive strength and low per cent elongation.

CPI Helps Its Own Baby Grow

Employs More and More Polyethylene for Equipment, Packaging and Protection; Finds Toughness, Corrosion Resistance, Moisture Barrier Properties Most Valuable

One of chemistry's own products — polyethylene — is changing chemical shipping habits, cutting laboratory hazards and reducing plant maintenance headaches. With plenty of the plastic available — production reached 630 million pounds in 1957—engineers in the Chemical Process Industries are becoming polyethylene-minded. They are continually looking for, finding and developing new uses for this tough, corrosion-resistant, inexpensive resin within the industry.

Shipping Chemicals in Polyethylene

Chemical manufacturers are packing and shipping both solids and liquids in a wide variety of polyethylene packs and polyethylene-lined and coated containers. Combinations of flexible bag and cardboard box, for example, are being used to transport fluids from producer to chemical consumer — without losing a drop. Even polyethylene is shipped in polyethylene-coated bags. Increasing utilization of the resin is based on its moisture barrier characteristics, corrosion resistance, toughness, nonbreakable properties, light weight and low cost.

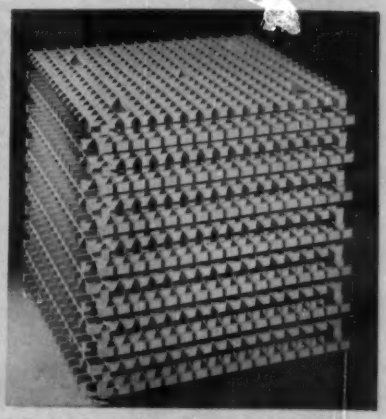
The government gave its blessing early in 1955, when the Interstate Commerce Commission approved shipment of nonregulated chemicals by road and rail in molded polyethylene drums. Last year these drums were OKed by the ICC for regulated products such as alcohols, acids and other corrosive liquids, sodium chlorite solutions and hypochlorite solutions.

Processing and Laboratory Equipment

A glance through any catalog of laboratory ware these days reveals that polyethylene is replacing glass wherever possible, to cut down on breakage. And for corrosive service, the chemist can now obtain items such as valves, pumps, sink traps and blade stirrers molded of polyethylene. Among the most recent developments in laboratory equipment is the polyethylene fume hood, including stacks, fans

MORE

Package for liquid chemicals combines pinhole-free polyethylene bag and corrugated box.



Polyethylene grid packings for water cooling towers. (Photo courtesy Fluor Products)

Extra-wide polyethylene film can serve as a temporary protective cover for materials or equipment.

August ★ **U.S.I. CHEMICAL NEWS** ★ 1958

CONTINUED

Polyethylene

and fittings. Here a service life of at least 20 years is expected from the resin.

More and more, polyethylene is showing up in the chemical plant in process equipment for corrosion resistance. One chemical plant is using polyethylene pipe to carry brine between two processing units, and steel pipe coated on the outside with polyethylene has been developed for underground use.

Polyethylene has been bonded to steel as a lining for storage tanks, piping, tank cars, process vessels and tank trucks. It has been woven into filter cloths, molded into waste and drainage systems, pump bodies, cooling tower grids and packings.

Polyethylene Film Gives Protection

Lengths of heavy-gauge, extra-wide polyethylene film are being employed in the chemical industry for all sorts of temporary situations and emergency problems. They are protecting equipment and bulk raw materials against dust and moisture in storage or transit, keeping personnel warm and dry during open air operations, providing temporary shelter after explosion or fire, lining ordinary vessels temporarily for corrosive service.

And the end is not yet in sight. Polyethylene producers are working constantly with engineers to use the resin's valuable properties more fully in the industry of its origin.

CONTINUED

Organo-Metallics

gents (organomagnesium halides) and tetraethyl lead. Recently, complexes of aluminum, boron, tin, manganese and other metals have become important as catalysts, intermediates, additives and end products in plastics and resin manufacture, the jet aircraft field and a host of other industries.

Organosodium compounds are being used as an economic route to other organometallics. Prepared from alkyl or aryl halides and finely dispersed sodium, the organosodium compounds are reacted with metal halides or alkoxides to yield otherwise hard-to-make Grignards, and valuable compounds such as lithium alkyls, dibutyl aluminum chloride, triphenyl boron and dibutyl tin.

Plant Demonstrates Ideal Handling of Bulk Sodium

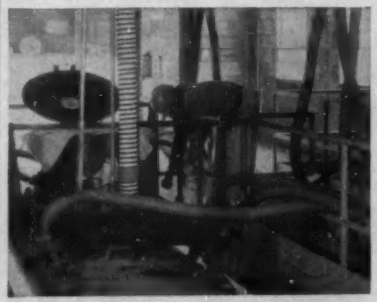
A model installation for receiving, pumping, filtering and storing tankcar quantities of sodium is now in operation at the zirconium plant of Mallory-Sharon Metals, Ashtabula, O.

This installation is designed to transfer two million pounds a year of metallic sodium — in 80,000-pound chunks — from tankcar to storage to process without contaminating the metal or bringing it into contact with any outside material. Here's how it works!

The railroad car, containing solid sodium under argon, is run into a receiving shed about 50 feet from the process building. Adjoining the shed are areas for oil storage, heating and pumping; sodium pumping, filtering and storage; and argon gas handling. Lines for argon, heating oil and molten metal connect the shed to these areas. The lines are attached to the car.

Hot oil is pumped to the tankcar heating coils, melts the sodium and heats it to 250°F. Argon is forced into the car to push the molten metal up into the sodium line, from which it is pumped electromagnetically through filters to storage. Complete instrumentation assures constant control of all variables.

The installation incorporates the most advanced techniques of sodium handling developed over the years by U.S.I. To help others working with large quantities of sodium, U.S.I. offers a booklet "Handling Metallic Sodium on a Plant Scale."



View of top of tankcar in shed shows connections for sodium, heating oil, argon. Sodium lines are heated via A.C. induction coils.

TECHNICAL DEVELOPMENTS

Information about manufacturers of these items may be obtained by writing U.S.I.

Isophthaloyl and terephthaloyl chlorides of 98% minimum purity are now in pilot plant production. Suggested as raw materials for fibers, films, protective coatings. Claimed to have greater reactivity than corresponding acids. **No. 1380**

Uses of permanent, non-electric magnetism in modern materials handling and magnetic separation equipment described in new, 48-page, free booklet. Covers chemical, plastics, food, ceramics, textile, paper fields among others. **No. 1381**

New adhesive for bonding polyethylene linings to steel tanks and other surfaces is a one-part, self-vulcanizing material. Need for primers on metal or plastic is eliminated. Bonds are temperature-stable, remain flexible. **No. 1382**

Microfilm storage is the subject of a new American Standard, drawn up for the purpose of protecting microfilm against humidity, temperature, dust and gas. Inspection methods are included. Copies can be purchased. **No. 1383**

Ethyl-di-n-propylthiolcarbamate, a selective herbicide for most grassy weeds, has just been registered by the Dept. of Agriculture for use with crops such as beets, flax, corn, beans. Limited quantities are being offered for sale. **No. 1384**

Three new synthetic polysulfide rubber caulking compounds are available which are said to have 400 to 500% elongation, excellent weathering, water resistance, flexibility. Can be used on metals, wood, clay products, glass. **No. 1385**

Proceedings of the 1957 Conference on Precautionary Labeling have now been published as a 52 page book which can be purchased. Includes all papers presented plus a list of those who attended. **No. 1386**

Glycol di-mercaptoacetate, a new dithiol just introduced, can act as a cross-linking agent and monomer for special polymerizations by addition across ethylenic unsaturation, and by reaction with active halogen. **No. 1387**

New non-flammable, cold solvent stripper for epoxy enamel coatings is designed for many of the newer epoxies usually very difficult to remove. Coatings are rapidly wrinkled and detached from base metal, rather than dissolved. **No. 1388**

Special 99% pure cetyl alcohol is now on the market which is claimed to meet or exceed the high standards of the Toilet Goods Association. Lead content is said to be 1 ppm max., arsenic content 1 ppm max. as As_2O_3. **No. 1389**

PRODUCTS OF U.S.I.

POLYETHYLENE RESINS

PETROTHENE® 200 Series — high quality resins for extrusion, injection and compression molding, film extrusion, paper coating, blow molding.

PETROTHENE 300 Series — special resins for electrical insulation use.

PETROTHENE 560 Series — black, compounded resins for pipe and mulch-film extrusion.

OTHER PRODUCTS

Heavy Chemicals: Anhydrous Ammonia, Aremonium Nitrate, Nitric Acid, Nitrogen Fertilizer Solutions, Phosphatic Fertilizer Solution, Sulfuric Acid, Caustic Soda, Chlorine, Metallic Sodium, Sodium Peroxide, Sodium Sulfite, Sodium Sulfate.

Pharmaceutical Products: DL-Methionine, N-Acetyl-DL-Methionine, Urethan USP, Riboflavin USP, Intermediates.

Alcohols: Ethyl (pure and all denatured formulas); Proprietary Denatured Alcohol Solvents SOLOX®, FILMEX®, ANSOL® M, ANSOL PR.

Organic Solvents and Intermediates: Normal Butyl Alcohol, Amyl Alcohol, Fusel Oil, Ethyl Acetate, Normal Butyl Acetate, Diethyl Carbonate, DIATOL®, Diethyl Oxalate, Ethyl Ether, Acetone, Acetoacetanilide, Acetoacet-Ortho-Chloranilide, Acetoacet-Ortho-Toluidide, Ethyl Acetoacetate, Ethyl Benzoylacetate, Ethyl Chloroformate, Ethylene, Ethyl Sodium Oxalacetate, Sodium Ethylate, ISOSEBACIC® Acid, Sebacic Acid, Urethan U.S.P. (Ethyl Carbamate), Riboflavin U.S.P., Pelargonic Acid, and 2-Ethyl Heptanoic Acid.

Animal Feed Products: Antibiotic Feed Supplements, BHT Products (Antioxidant), Calcium Pantothenate, Choline Chloride, CURBAY B-G®, Special Liquid CURBAY, VACATONE®, Menadione (Vitamin K_3), DL-Methionine, MOREA® Premix, Niacin USP, Riboflavin Products, Special Mixes, U.S.I. Permadry, Vitamin B_{12} Feed Supplements, Vitamin D_3, Vitamin E Products, Vitamin E and BHT Products.

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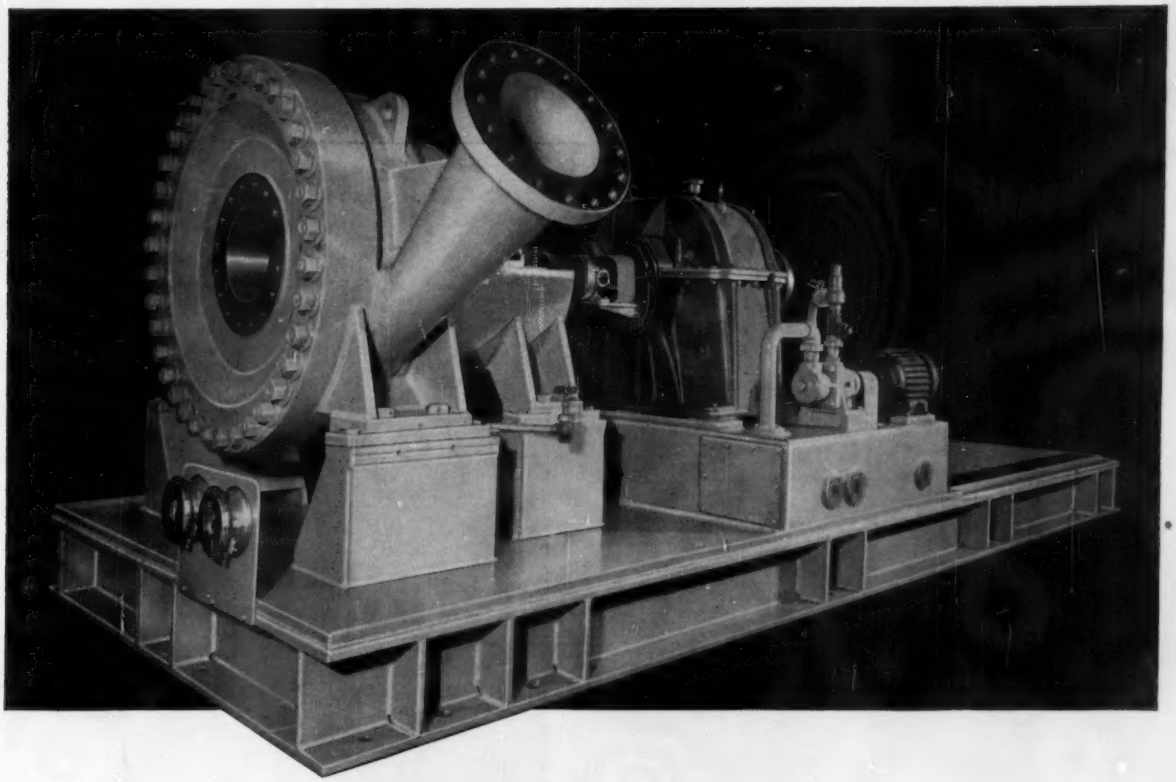


NEW

Single-Stage Barrel-Type
Allis-Chalmers Compressor

Boosts High Pressure Gas to Higher Pressure Levels in Range of 50 to 500 psia.

THIS new Allis-Chalmers development extends the range of single-stage compressors into high pressure levels previously handled by reciprocating type units.

The new compressor has all the advantages of a centrifugal compressor — compactness, pulsation-free operation, few wearing parts, easy maintenance.

The unit shown above, now in successful operation, boosts 3690 cfm of air from an inlet pressure of 185 psia to a discharge pressure of 240 psia. It is driven through a speed-up gear by an Allis-Chalmers 1250-hp motor.

The casing consists of three principal parts: the casing cylinder, a bolted casing head and a fabricated casing pedestal. A diaphragm which forms the gas diffuser passage is inserted into the casing cylinder. Excellent gas sealing is assured, since there is only one shaft extension and only one casing joint to seal against gas pressure.

For details, including a sectional view of this new compressor, call your nearby A-C representative, or write Allis-Chalmers, Industrial Equipment Division, Milwaukee 1, Wisconsin.

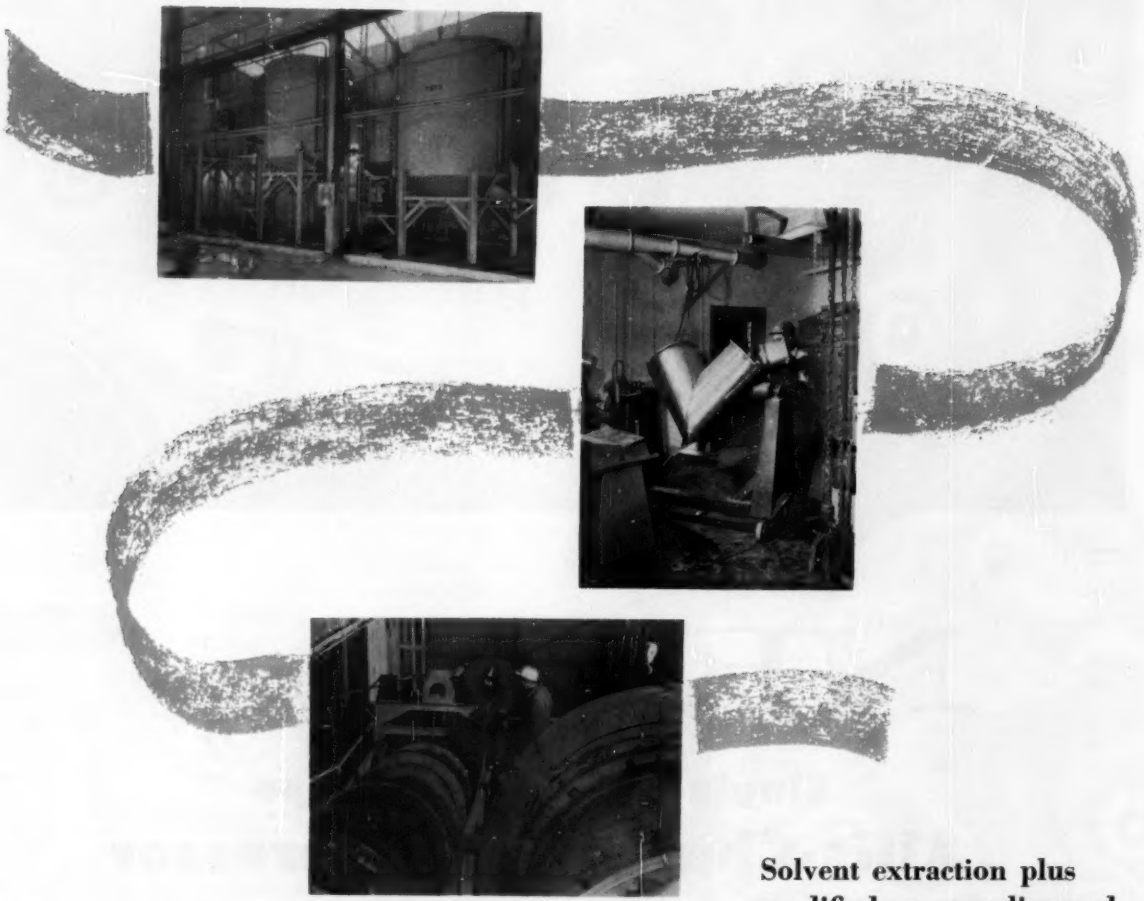
ALLIS-CHALMERS

A-5728

PRACTICE . . .

PROCESS FLOWSHEET

C. H. CHILTON



Solvent extraction plus modified ore-sampling and preparation yield uranium process dividends.

SX Line Wins Uranium From Variety of Ores

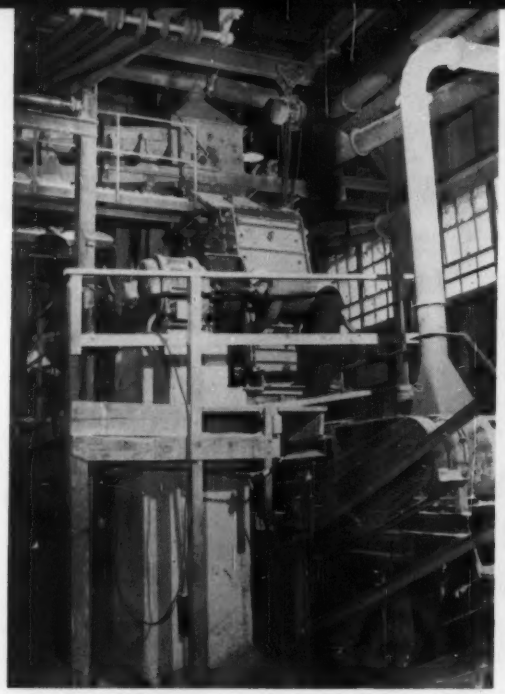
PROCESS industry companies, squeezed by economic belt-tightening, have sometimes found relief in specifications allowing processing of a wide variety of feedstock.

Now Vitro Uranium Co., faced with the job of handling a wide variety of ores, has helped introduce a new competitive era in uranium processing. The company recently revamped its Salt Lake City mill to recover by solvent extraction high-grade uranium concentrate from Colorado Plateau ores.

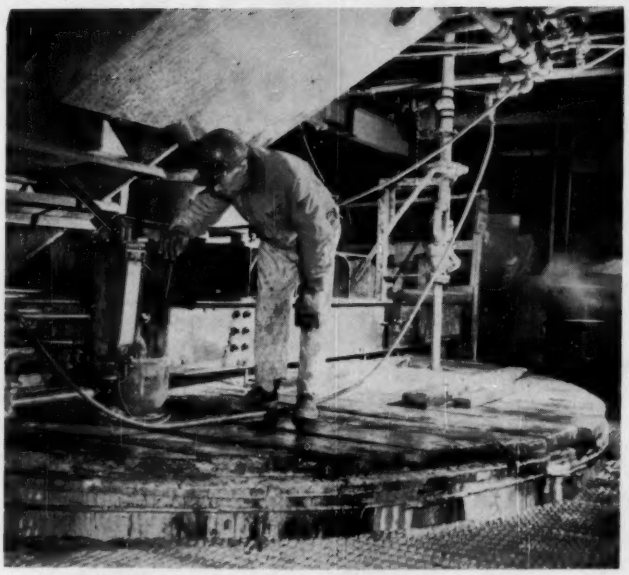
With the revamp completed last October, the 660-ton/day plant includes $1.5-million worth of improvements.

- A liquid-liquid extraction section replaced the more difficult phosphate precipitation operation.
- An ore-sampling plant, to handle increased sampling requirements, now does the formerly out-of-plant task.
- Both readily leached ores and those not readily leached can now be processed in the same acid-leach-

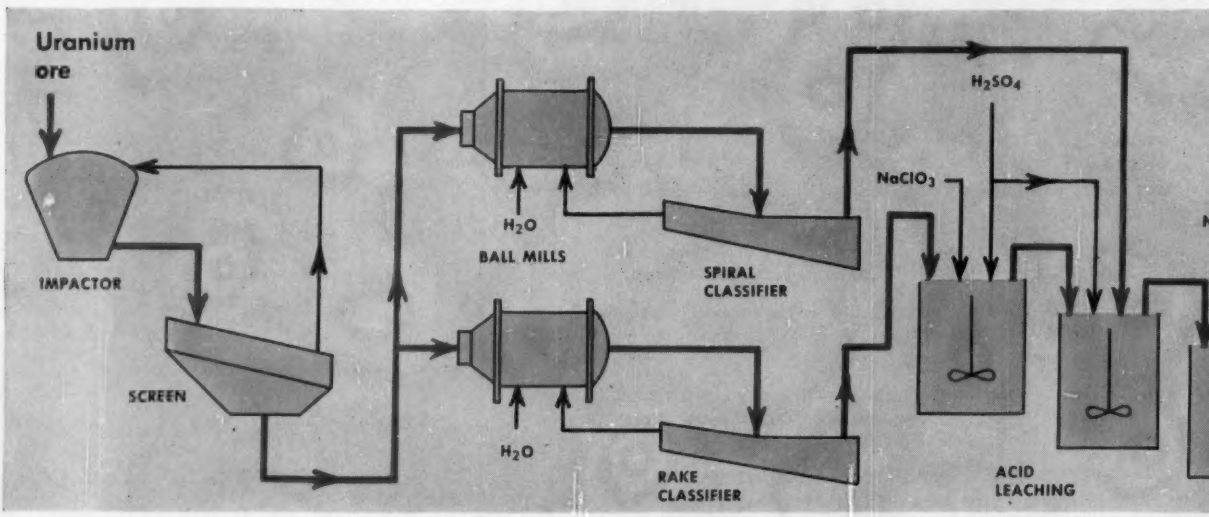
Unfold Flowsheet



IMPACT CRUSHER accepts coarse feed ore; reduces it to less than one-inch size.



ACID LEACHING line wins uranium from ore slurry using sulfuric acid and sodium chlorate in 10,000-gal. tanks.



ing line because of the addition of a second ore preparation circuit to the plant.

Heart of the process is the solvent extraction line. Extractant is 3% dodecyl phosphoric acid (DDPA) solution in kerosene. DDPA seizes uranium from acid-leach liquor in a continuous countercurrent operation.

▶**Two Other Additions**—Prior to Vitro's revamp, an outside company handled primary crushing and sampling of incoming ores. Coordination of this phase, coupled with revised AEC contracts requiring more extensive sampling, pushed costs of outside services beyond justification. Facilities added to existing classification equipment made in-plant sampling possible.

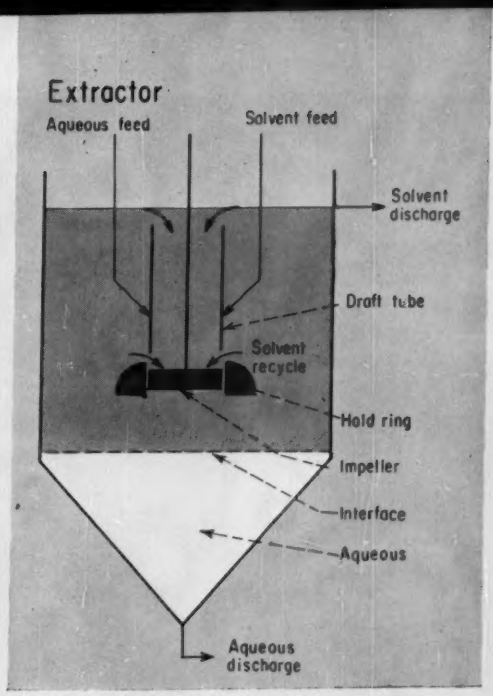
Greater flexibility is the keynote in adding another ore preparation circuit. The second ball mill-classifier section provides a shorter path for readily leached ores and maintains continuous production during shutdown of other line.

▶**Economic Gains**—Advantages claimed for the SX process, aside from handling of wide variety of ores, include economically important one of a higher-grade uranium product. Vitro Uranium's president, W. B. Hall, also cites savings in reagent costs. Both DDPA and hydrochloric acid (the stripping reagent) are recovered in large part for reuse.

Continuous nature of the process is also an inherent advantage. A larger throughput, with closer control on specifications, can be maintained.

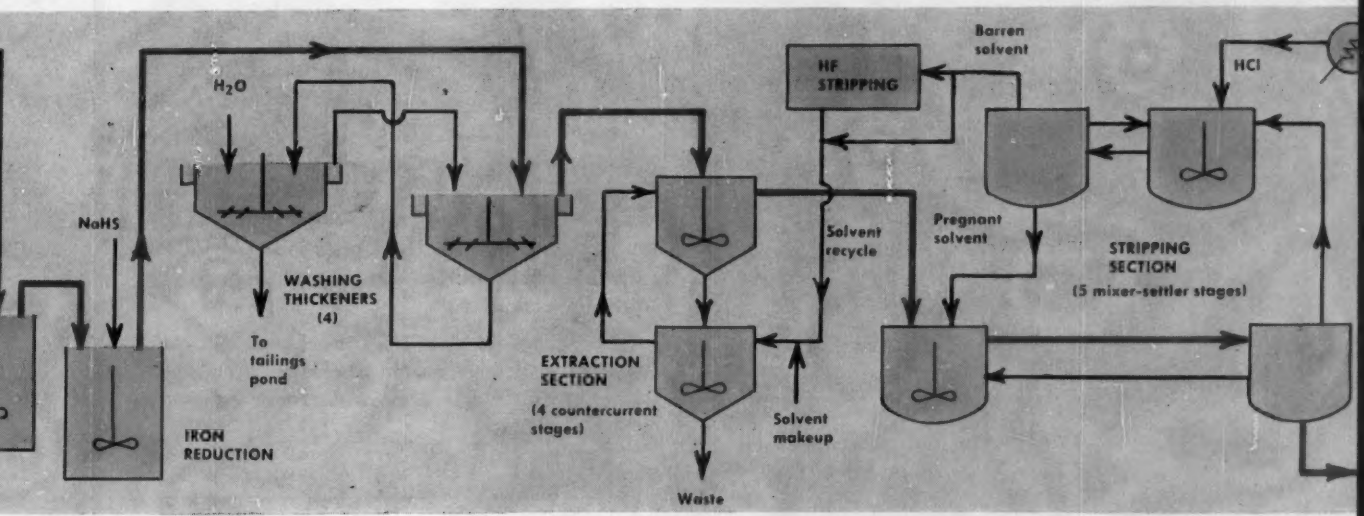
DDPA is prepared on the spot by reaction of phosphorus pentoxide with 2,6,8-trimethyl nonanol-4 and subsequent hydrolysis of the pyrophosphate ester. This solvent ensnares hexavalent uranium, contained in sulfuric acid leach liquor

WASHING THICKENERS receive leach slurry; wash and thicken it to separate uranium-bearing overflow liquor from solids.



SOLVENT EXTRACTION tanks combine mixing and settling to capture uranium in DDPA.

VACUUM R... diuranate aft...



as UO_2^{++}, carrying it into the organic phase. Extraction is typically carried out at aqueous-to-organic ratio of 7:1.

▶**Way It Flows**—Vitro's process route follows the conventional start. Impact crushing reduces incoming ore to nominal 5/8-in. mesh. Screen undersize feeds to the sampling system, producing a final sample of 1 lb./ton of ore fed.

Crushed ores (predominantly autunite, uraninite and carnotite) are blended immediately or from stockpile to give best uranium recovery. A ball mill wet-grinds "difficult-to-leach" ores at 60% solids to −28 mesh. "Easy-to-leach" ores enter a parallel circuit and are reduced to −20 mesh.

▶**Versatile Leaching**—"Difficult" ores are introduced to first stirred tank of the leaching section, along with sulfuric acid and sodium chlorate. Further along the countercurrent series, "easy" ores enter, together with additional required acid. Sodium hydrosulfide is added to the last tank to reduce feric iron to ferrous iron and precipitate heavy metals as sulfides.

Four 70-ft.-dia. washing thickeners separate gangue and sulfides from the uranium-bearing pregnant liquor with the aid of a flocculant. Underflow solids, pumped from one stage to next, end in the tailings pond. The relatively clear overflow from first stage feeds to the four-stage solvent extraction line.

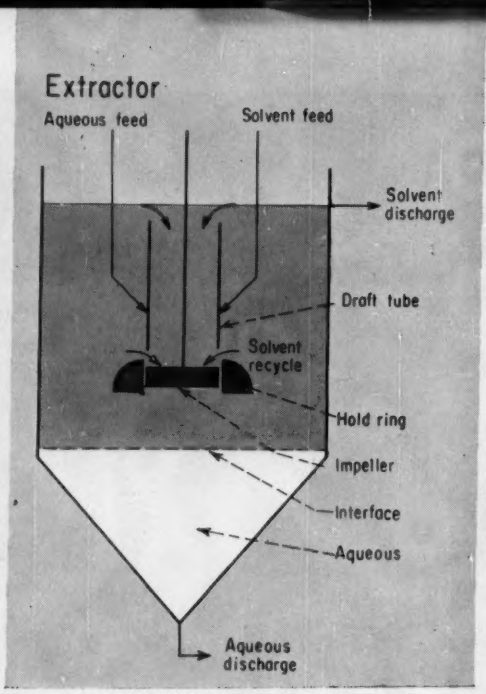
▶**SX Way**—Extraction device is a 20-ft.-dia. tank of internal mixer-settler type. A shrouded impeller submerged in the solvent phase maintains continuous organic phase and provides intimate interphase contact. Emulsification and entrainment are minimized by

solvent rec... zone. Produ... stantially e... for 3600-lb.

Gravity ... SX line ... pumped flo... solvent, ha... as 99.5% ... pumped fro... hydrochlori... tion.

▶**Stripping** ... countercurr... with 10*N* ... UO_2Cl_2-HCl ... consists of

ASHING THICKENERS receive leach slurry; wash and thicken to separate uranium-bearing overflow liquor from solids.



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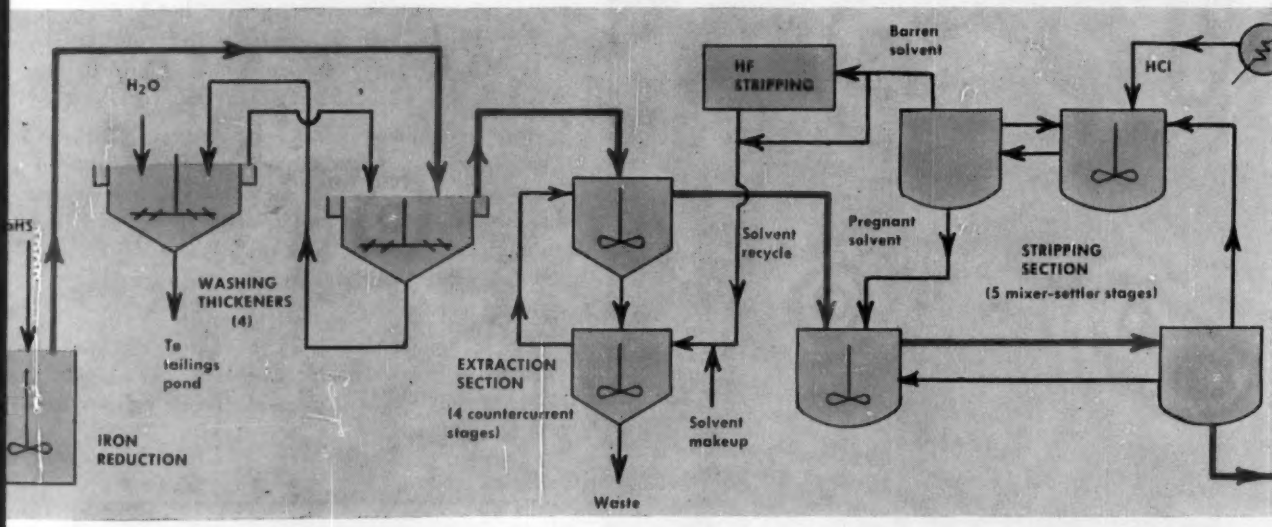

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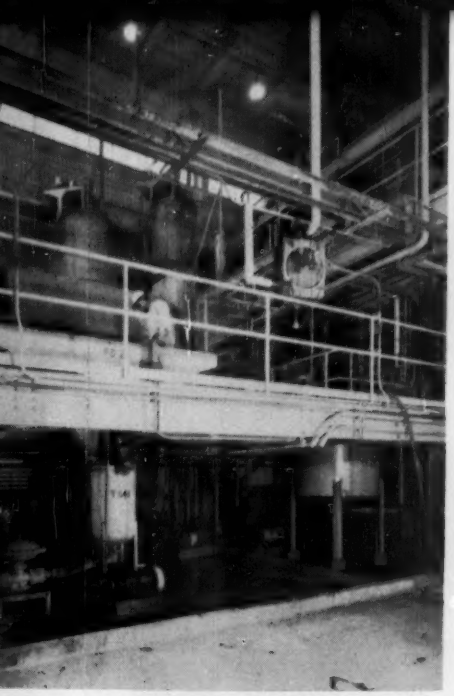
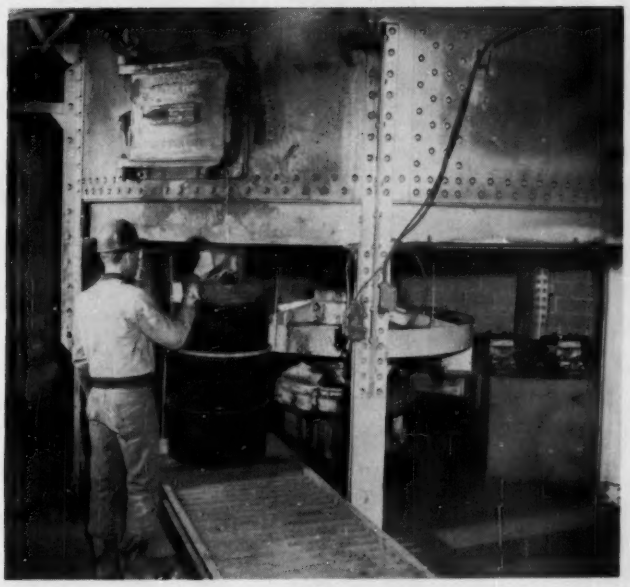
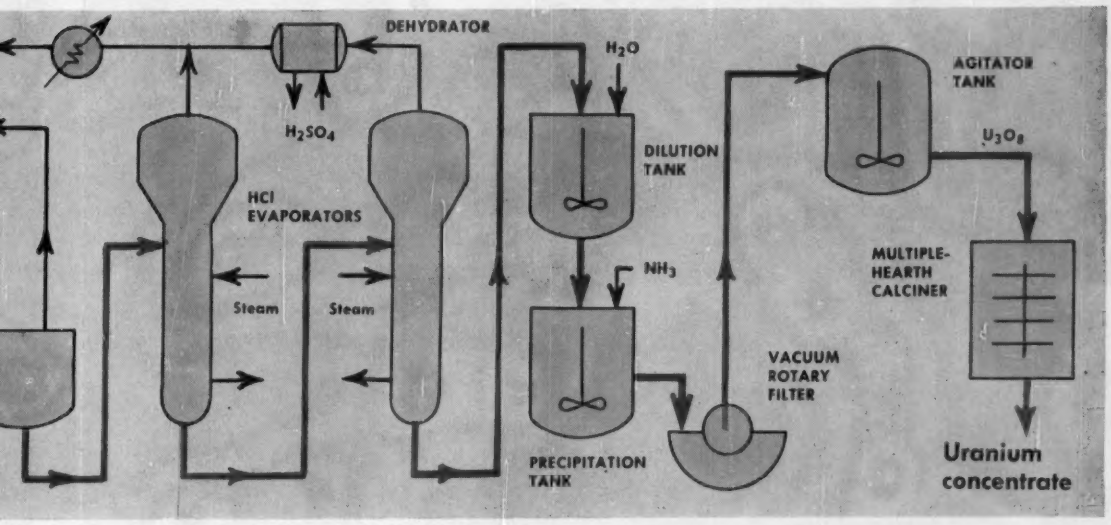


CUUM ROTARY FILTER collects ammonium anate after precipitation step.



MULTIPLE-HEARTH CALCINER dries filter cake, lowering chloride level and yielding high-spec uranium concentrate.



ent recycle within the mixing e. Production of U_3O_8 has "subtially exceeded" the designed 3600-lb. U_3O_8 day.

ravity flow of solvent in the line is countercurrent to nped flow of raffinate. Rich ent, having recovered as high 99.5% of feed uranium, is nped from the first stage to the rochloric acid stripping sec-

ripping the Stream—Five-stage ntercurrent solvent stripping n 10*N* HCl acid produces a Cl_2-HCl concentrate. Each stage sists of two interconnected 10-ft.-dia. tanks, one of which violently agitates the mixture, the other settling it. Overflow is organic, while pumped underflow is HCl stream.

Stripped DDPA is recycled to the SX section. A dilute hydrofluoric acid stripping section processes part of the DDPA recycle stream to remove buildup of solvent poisons, such as titanium and thorium, that are not removed by HCl acid stripping.

▶ **Finishing It Up**—The uranium-rich HCl flows to top of a two-stage, vertical falling-film evaporator. Concentrated sulfuric acid dries vapors from the second stage, which are then mixed with first stage vapors to deliver 10*N* recycle HCl.

Addition of ammonia to water-diluted evaporator heel precipitates ammonium diuranate. A vacuum rotary filter collects this solid from the slurry.

The filter cake discharges to an agitated tank, from which it is pumped to a multiple-hearth calciner. Roasting converts the salt to U_3O_8 (as hydroxide) and lowers chloride level. Final products have approached 90% U_3O_8, well over AEC specifications.

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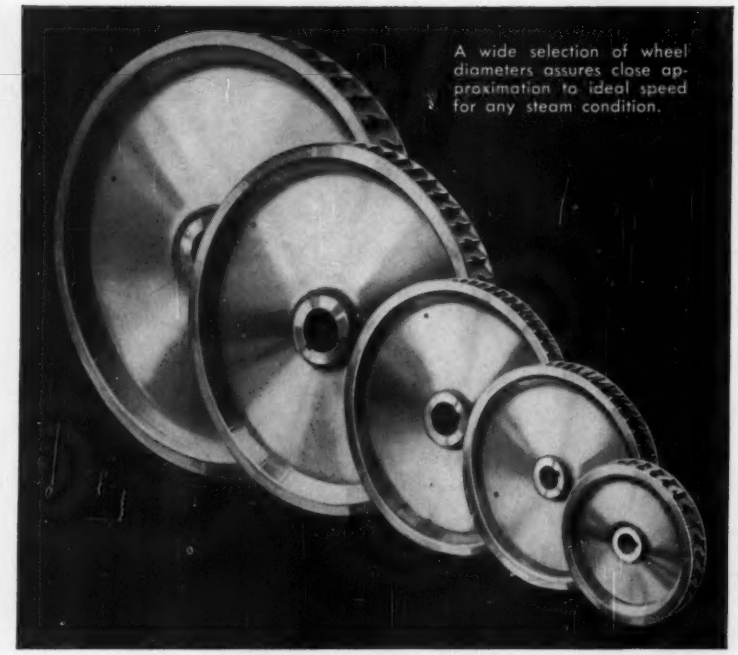

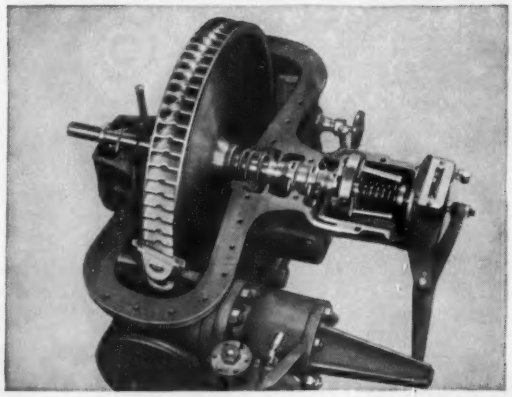

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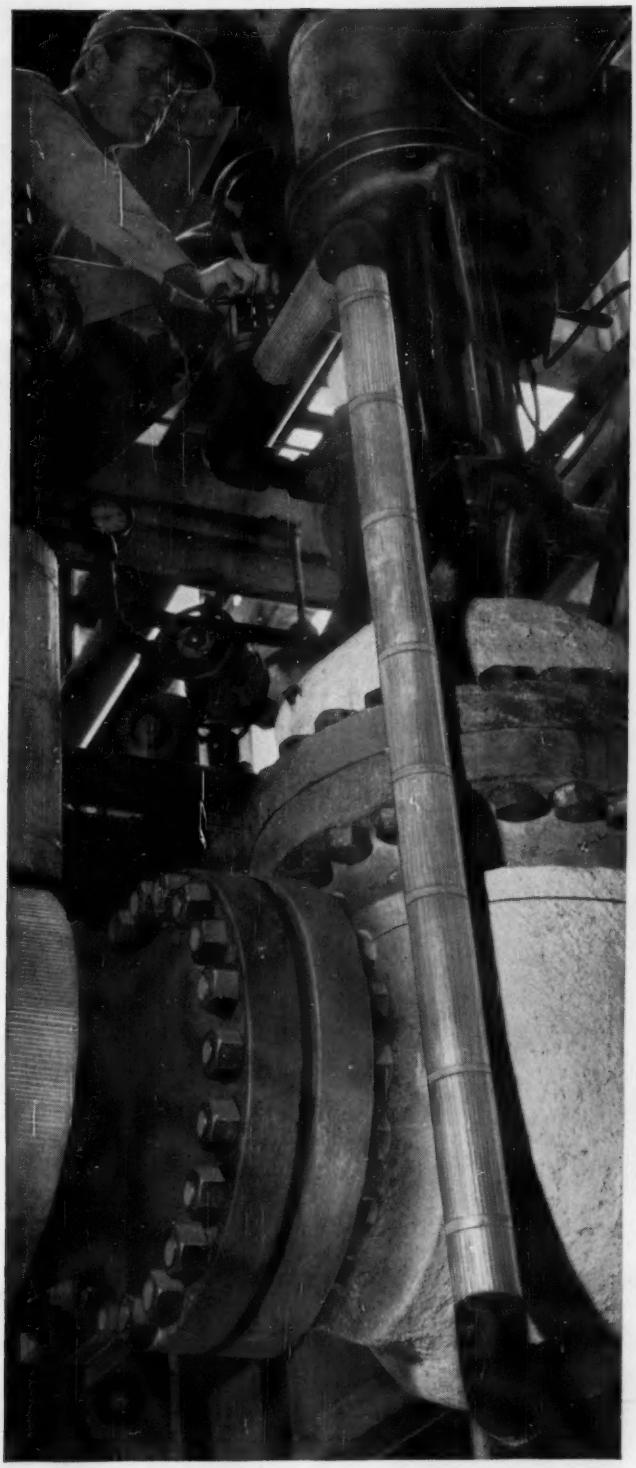

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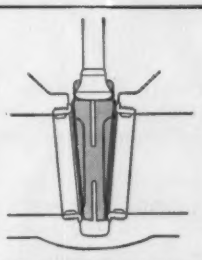

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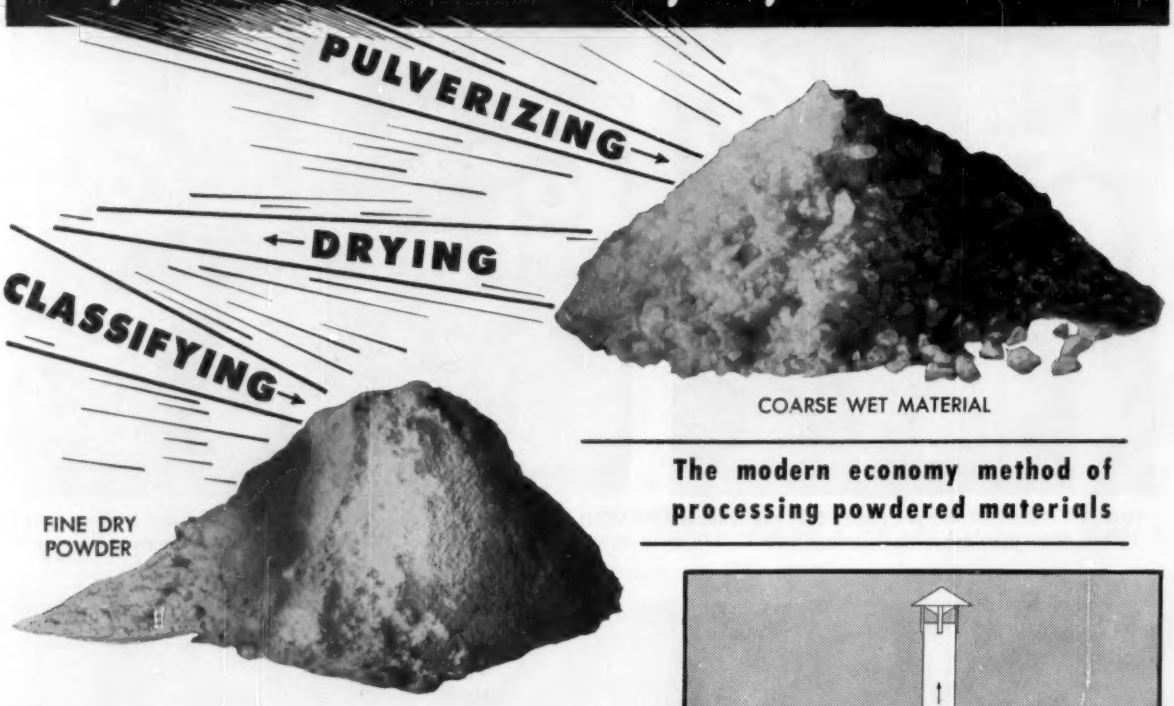

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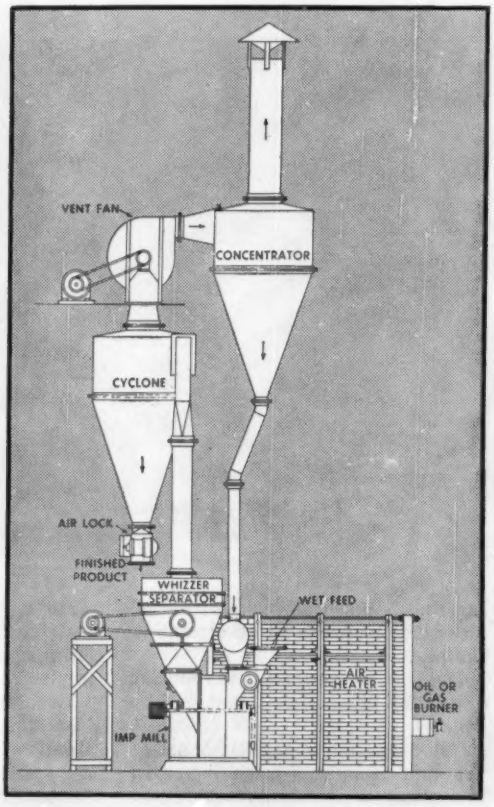

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Department Index

Process Flowsheet 104
Feature Articles 113
Design Notebook 131
You & Your Job.....133
Operation & Maintenance 136
Corrosion Forum 142

Extraction produces uranium process economies.... 104

By modifying ore preparation and adopting solvent extraction, Vitro Uranium now wins a higher-specification concentrate from a wide variety of ores. Here's the route.

Want to get rid of acid gases? Try hot carbonate..... 113

A hot solution of potassium carbonate makes short work of removing large quantities of acid constituents from gas streams—and more economically than amine treatment.

New combustion principle offers versatile features.... 117

Maybe you can make use of the novel Zimmermann process for burning organic matter, including wastes, in dilute aqueous solution, directly with high-pressure air.

Best estimation methods for Prandtl number..... 121

Even for the simple gases our experimental values are uncertain. Theoretical approaches are inadequate at the present time. This article tells you what method to use today!

Electrochemistry explains oxidative corrosion..... 125

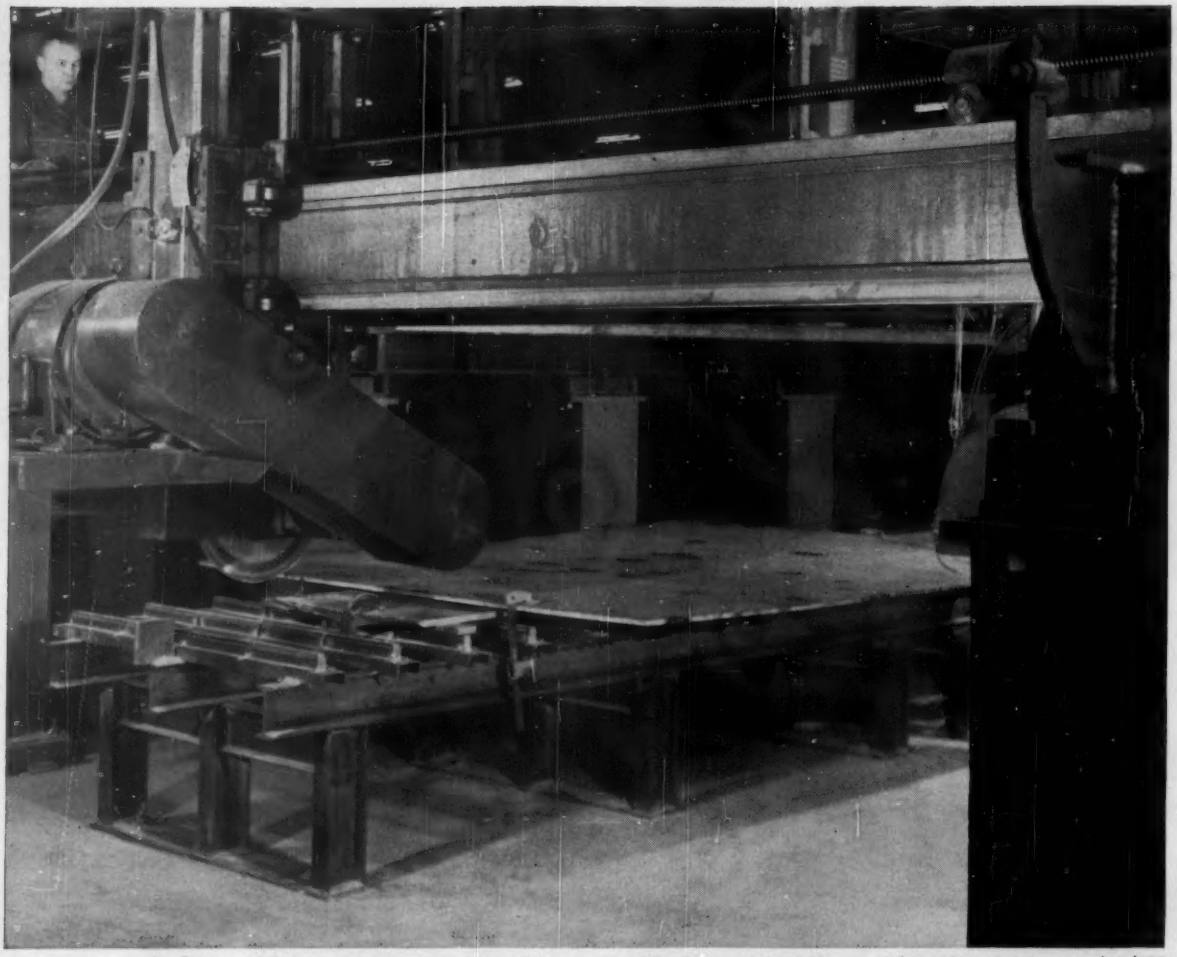
Review the fundamental principles of electrochemistry and learn how these apply to practical corrosion problems and to the various patterns of corrosion attack.

How to find a job in an out-of-state location..... 133

This new free service is successfully serving employee and employer alike. 78 offices stand ready to serve you as a professional. How the systems work. Some success stories.

Tankcar agitation problems can be licked..... 136

In the everyday use of tankcar agitation, you're up against some real problems. Get more versatility out of your tankcar by knowing what equipment to use.



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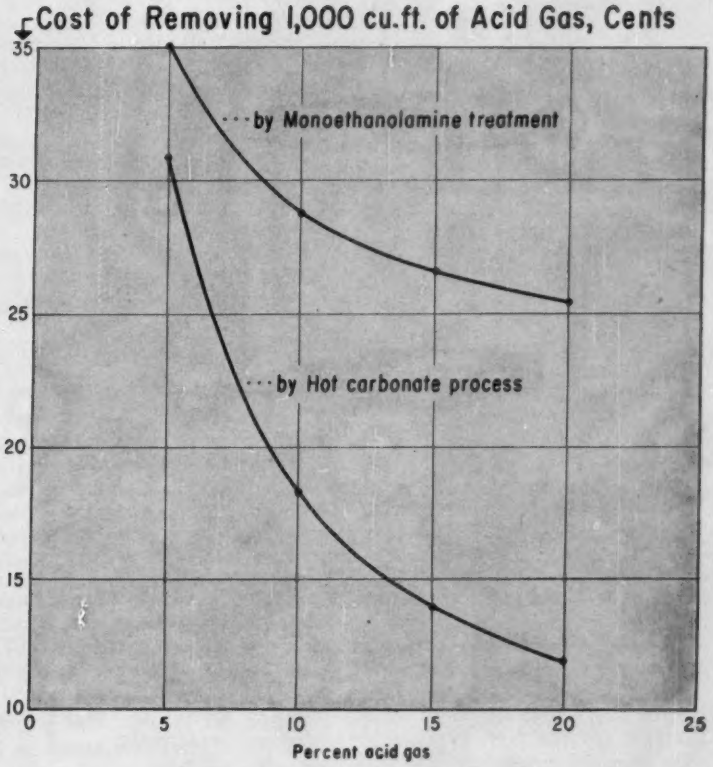


For bulk removal of acid gases . . .

Costs Favor Hot Carbonate Process

A. G. EICKMEYER, Process Consultant, Kansas City, Mo.

RELATIVELY new, the hot-carbonate process for removing acid constituents from gas streams is now commercially operating in at least seven plants in the United States alone. Application outlook for the future is even brighter. This article presents some of the most recent information about the process, its comparative economics and some of its corrosion history.

The hot carbonate process is so named because acid gas components, such as carbon dioxide and hydrogen sulfide, are absorbed under pressure by a hot solution of potassium carbonate. Bicarbonate ions are always present in this cir-

Comparative Process Economics: Hot Carbonate vs. Monoethanolamine, Table I

	For 5% Acid Gas Content		For 10% Acid Gas Content		For 20% Acid Gas Content	
	Hot Carbonate	MEA	Hot Carbonate	MEA	Hot Carbonate	MEA
Investment including utilities (thousands of dollars)	1,600	1,450	1,890	2,360	2,465	4,150
Operating Cost/Yr. (thousands of dollars)						
Labor and Supervision	100	100	100	100	100	100
Maintenance (4% of capital)	64	58	75	94	98	166
Fuel Gas (20¢/million Btu.)	112	206	150	412	230	824
Chemicals	10	20	12	25	16	35
Fixed Charges (16% of capital)	256	232	303	378	395	664
Total	542	616	640	1,009	839	1,789
Cost/thousand cu. ft. of gas treated, cents	1.55	1.76	1.83	2.88	2.40	5.11
Cost/thousand cu. ft. of acid gas removed, cents	31.0	35.2	18.3	28.8	12.0	25.6

culating solution and, during removal of carbon dioxide, the process reactions involve a shift towards a greater or lesser proportion of bicarbonate as the solution cycles between the absorption and stripping steps. Absorption proceeds at substantially the same temperature as is used for subsequent low-pressure steam regeneration. Similar reactions occur during the absorption of hydrogen sulfide, which is tied up in solution as the hydrosulfide ion.

So far, major applications for the process have been in the petrochemical field. In addition to treating natural gas, hot carbonate units are particularly applicable to synthetic ammonia plants where carbon dioxide, which is a poison to the catalyst, must be removed down to a few parts per million. The process is also being used in the production of hydrogen, and for cleanup of recycle ethylene in an ethylene oxide plant.

Table II

Mixed H_2S-CO_2 Removal
(Courtesy U.S. Bureau of Mines)

Feed Stream* Composition, %		Effluent Composition, %	
CO_2	H_2S	CO_2	H_2S
11.3	0.51	0.33	0.002
11.0	0.556	0.40	0.004
10.9	0.578	0.34	0.004
10.7	0.927	0.23	0.011
11.5	4.4	0.1	0.01

*Feed gas at 300 psig.

Details and Limitations

Ordinarily, a sequence of two or three carbon dioxide removal steps is employed, with initial bulk removal accomplished by hot carbonate. Degree of cleanup designed into this initial step is dependent upon the nature of subsequent purification steps.

Residual carbon dioxide in effluents from present hot carbonate units varies all the way from 2 or 3% down to less than 0.2%. However, the process could be designed for even better cleanup if desired. It has not yet been used commercially for the removal of large quantities of hydrogen sulfide, but a plant of this kind for sweetening natural gas is now under construction, and is expected to be in operation at some time later in this year.

Some pilot-plant work on a gas containing a mixture of carbon dioxide and hydrogen sulfide has been conducted by the Bureau of Mines. Data from several of the runs are shown in Table II. The ratio of inlet concentration to outlet concentration is generally several times greater for H_2S than it is for CO_2. This portrays the fact that hot carbonate removes the H_2S preferentially. The reason for this is believed to be that CO_2 must first react with water to become an acid, while on the other hand, H_2S is already an acid.

Limitations of the process revolve about the partial pressure of the acid gas, and our present lack of complete knowledge regarding corrosion problems. Hot carbonate is not recommended for low-pressure absorption, or for high-pressure absorption of a low concentration of acid gas. As a rule of thumb, when the partial pressure of acid gas is 20 psi. or greater, a hot carbonate unit should be considered. This rule may require some modification depending on plant size and the local cost for utilities. Regarding corrosion problems, which will be outlined later, many of the troubles experienced by existing plants could have been circumvented by more careful initial design and selection of the various materials of construction.

Process Economics

Primary incentive for use of the hot carbonate process is a matter of economics. Under favorable conditions of pressure and acid gas content, initial investment and operating costs for hot carbonate plants are considerably less than for amine plants. The main reason for these economies stems from the use of the hot circulating solution for absorption—expensive heat exchangers are not required, and less steam generation and cooling equipment is needed. Also, since hot carbonate units require a lower level of heat than that required for amine regeneration, waste-heat recovery is frequently practical. For example, it's possible to use low-pressure steam generated by ebullient cooling of gas-engine drives, or via recovery of waste heat from process streams.

A comparative economics study of the hot carbonate and monoethanolamine processes for treating natural gas, based on meeting a pipeline specification of 0.25 grain of sulfur per 100 cu. ft., is summarized in Table I and Figs. 2 and 3. Since the composition of natural gas can vary considerably, the study compares relative economics at several concentrations of acid gas components. A similar economic study for the bulk removal of carbon dioxide from synthesis gas containing 34% CO_2 is given by Mullowney in the *Oil and Gas Journal*, Feb. 10, 1958.

Data in Table I are based on treating plants with a feed-gas capacity of 100 million cu.ft./day, and an absorption pressure of 500 psig. Amine plant designs assume 15% MEA and a net loading of 0.3 mole acid gas per mole of amine, as generally recommended to avoid corrosion. This corresponds to 2.32 cu.ft. of acid gas per gal. of solution, and a solution circulation rate directly proportional to the acid gas content. Hot carbonate design assumes use of 30% potassium carbonate solution and a loading varying from 2.1 to 4.2 cu.ft./gal., depending on the partial pressure of acid gas.

As shown by Figs. 2 and 3, costs for an amine plant increase sharply with acid gas content. This is because of the loading limitation imposed to avoid corrosion, which in turn results in high circulation rates and steam consumption.

On the other hand, the hot carbonate process uses the available pressure of acid gas more effectively. Hence the costs increase with acid gas content at a much lower rate. It should be noted that the two lines of Fig. 3 would intersect to give equal costs at about 4% acid gas. At this point, the total pressure of 500 psig. corresponds to a partial pressure of 20 psi.—the rule of thumb mentioned before.

To illustrate the effect of the different utilities requirements for the two processes, investment data in Table I are shown for a complete plant, including steam generation and cooling systems. However, costs for plant site and housing for plant personnel are not included in the study.

Corrosion Considerations

When carbon dioxide is the only acid gas component to be removed, about 3,000 ppm. of potassium dichromate has proved to be a good corrosion inhibitor. However, two of the plants now operating on natural gas have to contend with traces of hydrogen sulfide. This reacts with the dichromate, rendering it unsuitable. Thus, a good corrosion inhibitor is needed for sour-gas service, and work is proceeding on this matter at present.

As an alternative, we may use suitable materials of construction for sour gas service. Carbon steel is generally satisfactory for all items of equipment except those in certain critical locations. For example, a stainless steel such as Type 316 is ordinarily used as a material of construction for the letdown valve and rotating elements of the pumps.

Knowledge of material requirements for pump casings has been clouded to date by the frequent occurrence of cavitation, which contributes markedly to early failure—it should be avoided in the design and operation of any plant. For example, in the early operation of one hot carbonate plant, pumps suffered from severe erosion-corrosion; later, under more favorable conditions, the carbon steel casings proved satisfactory. Pump corrosion experience for a number of plants is summarized in Table III.

As a final note on corrosion, it should be remembered that since potassium carbonate solution is an electrolyte, both the absorber and

One-Stage Hot Carbonate Process

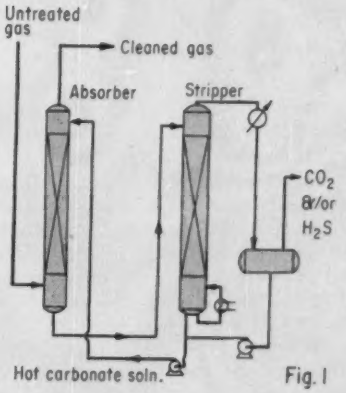


Fig. 1

Plant Investment

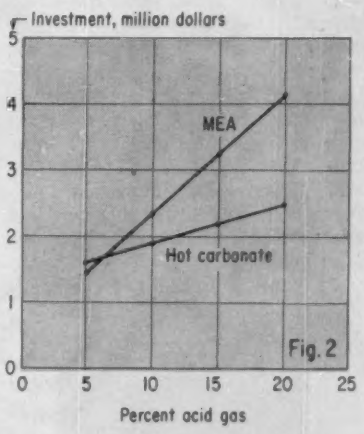


Fig. 2

Feed Gas Treating Costs

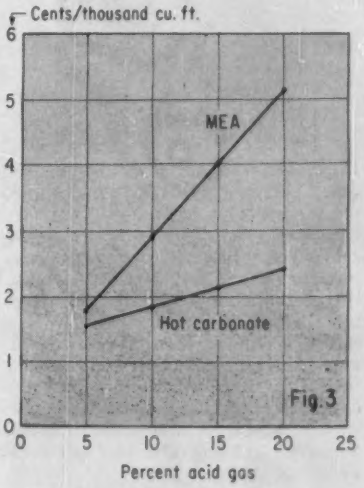


Fig. 3

regenerator vessels must be stress-relieved to avoid stress corrosion.

Variables Complicate Design

There are a number of design variables and equipment-sizing problems that bear much influence on the successful operation of a complete hot carbonate plant. Thus, problems of scaling up from pilot plant to full commercial size have, in some cases, limited realization of all of the process' advantages. Typical variables include: compositions of the solution and gas; absorption and regeneration pressures; absorption temperature; steam needs; circulation rate; vessel configuration; and number and type of trays, or alternately, packing material and height of packed beds.

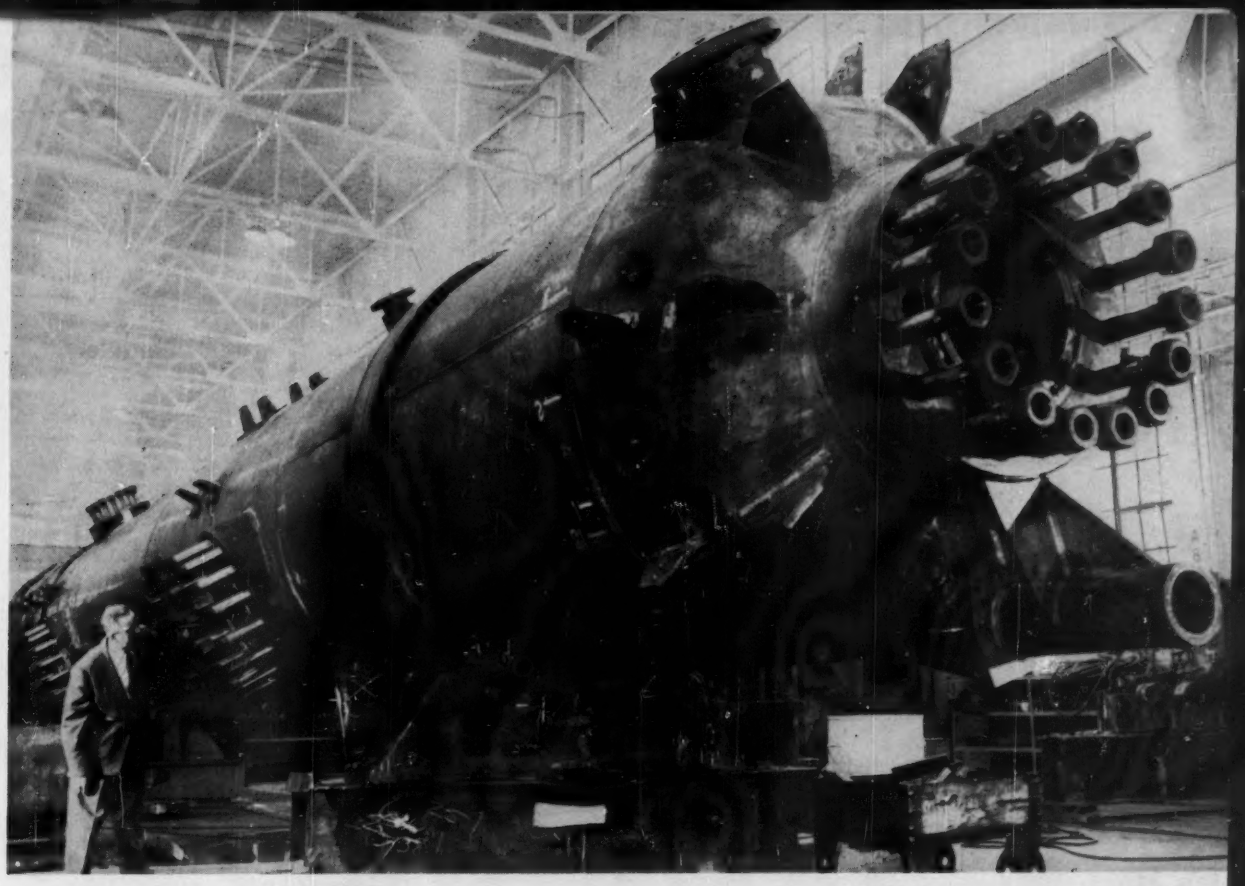
With so many variables to be considered, the importance of experience and ability on the part of the designer becomes apparent. Furthermore, although equipment is fixed once a plant is built, there are still a number of operating variables that are subject to change, and frequently, improved performance can occur at conditions that differ considerably from design basis.

In summary, the hot carbonate process shows important advantages over an amine process for removal of acid gases having a high partial pressure. For CO_2 removal, the process has proven itself in a number of chemical plants, and it can be recommended for Btu.-improvement of sweet natural gas. With sour gas, at present, the corrosion problems are somewhat unknown. However, it is anticipated that these problems will be defined and resolved in due course. And finally, it is predicted that with improvements in design, the process will come into widespread use.

A. G. EICKMEYER, an engineering consultant since early 1957, designed the largest hot carbonate plant in the United States. In addition, he's developed process improvements for seven operating hot carbonate plants. He presented a preliminary draft of this article before the March 1958 Gas Conditioning Conference in Norman, Okla. Eickmeyer earned his BSChE at Purdue, and his master's degree at the University of Utah. His earlier business associations include Stanolind Oil and Gas Co. and J. F. Pritchard and Co.

Table III
Pump Corrosion Experience at Seven Hot Carbonate Plants

Original Pumps	Materials	Performance	Replacements
Two-stage centrifugal. 857-ft. head at 564 gpm.	Cast iron case, cast iron impeller.	Severe corrosion-erosion of impeller and casing after 100 hr. operation. Trace of H_2S in feed gas.	Same pump with 316 SS case & impeller, 316 SS Stellite wear rings.
Vertically split single-stage, double-suction, 3,550 rpm.	Cast steel case, cast iron impeller.	Erosion-corrosion of impeller after 3 wks. Packing with water purge. Some noise, possibly cavitation.	Spare pump, same as original, with 304 SS case and impeller. Not in service.
Two-stage 3,600 rpm., 800-ft. head at 115 gpm.	Cast steel case, cast iron impeller, cast iron wear rings.	Trace of H_2S in gas. Erosion-corrosion of cast iron impeller and case after 4 wks.	Same pump with 316 SS case, impeller and wear rings.
Three-stage, 1,750 rpm.	Cast iron case, bronze impeller	Original: poor suction head; cavitation. Corrosion at wear rings. Impeller lasted 30 days. Replacement: impeller lasted 60 days, wear at interstage seals. Present pump: maintain 3,000 ppm. inhibitor. No corrosion in 1 yr.	1st replacement had carbon steel case and impeller. Present pump same with 6-stage booster; 3–4% Ni cast iron case, 316 SS impeller.
Two-stage, 3,500 rpm.	Cast iron case, 304 SS impeller, 304 SS wear rings.	Inadequate suction head, cavitation. Impeller lasted 3 mos.	New pump, all stainless steel.
Two-stage, 3,550 rpm.	11–13% chrome case, impeller & wear rings.	Rapid corrosion occurred when gas contained H_2S, which poisoned dichromate inhibitor.	Same pump, with 316 SS case, impeller and sleeves; Stellite wear ring facing.
Single-stage, 3,850 rpm.	Cast steel case, Cu-free, Ni-resisting impeller, 11–13% chrome wear rings.	Cavitation, general corrosion. Erosion-corrosion of case and impeller.	Single-stage, 1,750 rpm. booster pump added; 4-6% chrome case.



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- Consumes aqueous chemical, paper mill and sewage waste liquors.
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F. J. ZIMMERMANN, President, Salvo Chemical Corp., Rothschild, Wis.

THE wet oxidation of wastes is a new continuous method of combustion with air at high pressures which oxidizes organic matter dissolved or suspended in water. Wastes are burned with water present as completely as the usual method of first evaporating the water and then incinerating the dried residue. The end products in both cases are steam, nitrogen, carbon dioxide and ash.

The chief objective of this new process is to dispose of industrial wastes. Another asset of the method from an economical viewpoint is power, chemical or energy recovery from cheap fuel sources.

Since our initial process development work in 1944, in our laboratory and pilot plant we have totally oxidized by the wet oxidation process the following kinds of wastes: mill effluents from the Kraft, sulfite and semichemical paper processes; primary, activated and mixtures of sewage sludges; dairy and slaughter house wastes; polluted chemical plant and oil refinery streams.

Two commercial units have been designed—one is operating now and the other will start up later this year.

Basic Wet Oxidation Process

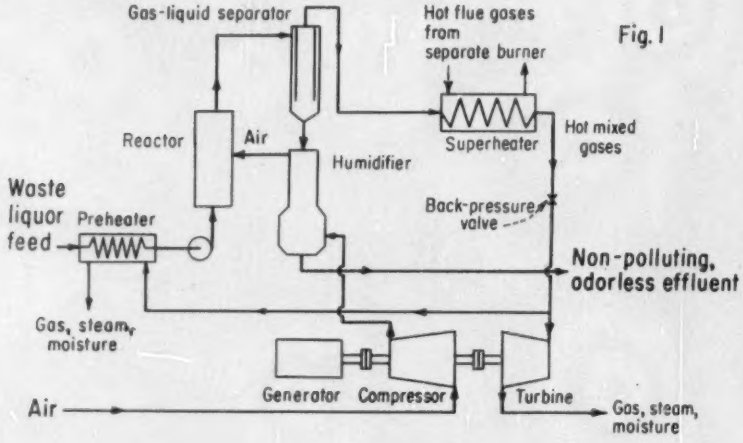
As shown in Fig. 1 air and waste liquor are fed into the process, and non-polluting, odorless liquor and combustion products are withdrawn.

The liquor is preheated by exit reactor gases or steam during start-up to about 300 F. where a reasonably fast oxidation can start. For feed with high concentration of oxidizable materials, the heat of reaction is high enough that cold liquor can be fed to the reactor.

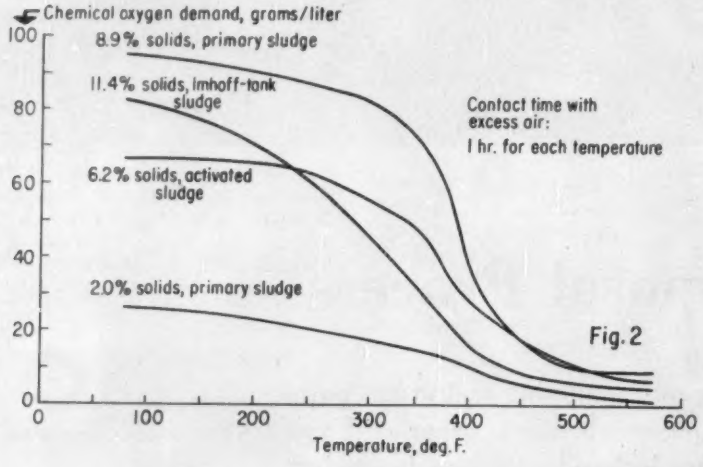
Air is mixed with waste liquor in the reactor—a vessel with sufficient hold-up capacity for complete reaction. Reactor temperature can be selected anywhere below 705 F.—water's critical temperature, where there's no longer a liquid phase.

We've gotten complete oxidations

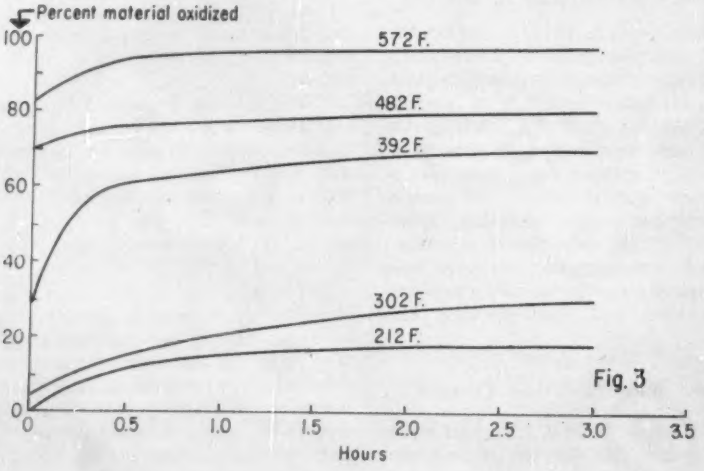
Flow Diagram for Wet Waste Air-Oxidation Process



Amount of C.O.D. Removal is Mainly Function of Reaction Temperature



High Temperatures Give Low Reaction Time and High Oxidation



at 300 F., though rates are too slow for practical applications at such low temperatures. Typical reactor conditions are 500-600 F. and 1,000-2,200 psig.

Reactor products move forward continuously. In some cases they give up excess heat in an exchanger to form process steam. Next the liquid and gas phases are separated. The water or liquid phase contains the ash and passes countercurrently to the incoming air in a humidifier. Here air is heated and oxidized effluent liquor is cooled.

Reactor gases become saturated with steam by contact with water in the reactor. These gases may be superheated before expansion through a gas turbine, which supplies power for the air compressor and liquor pumps.

A back-pressure valve in the exit gas line keeps the system at constant pressure. An automatic valve continuously discharges the water effluent.

Oxidation proceeds smoothly only if liquid water is present, and usually stops if it's not.

Technical Bases for Process

Variation of Oxidation With Temperature—In Fig. 2 are curves showing the amount of waste oxidized when an aqueous fuel (waste liquor) contacts excess oxygen at different temperatures. These data are for sewage sludges, but the curves are typical for all wastes.

The chemical oxygen demand (C.O.D.) of the liquor is found by the chromate method, which we think best corresponds to the actual required quantity of air or oxygen.

At each temperature a definite amount of oxygen demand is removed from the solution or suspension. This amount is independent of the quantity of excess oxygen. Therefore it's unnecessary to provide an excess of air as in usual boiler installations.

In fact this process operates with only enough excess air that oxygen is just detected by the stack gas analyzers. The gas products to the turbines contain up to 20% CO_2 compared to boiler gases with 11-12% CO_2.

Two conclusions can be drawn from Fig. 2. Only at temperatures of 450 F. and higher can a considerable amount of C.O.D. (say 80% of initial) be removed. But the final effluent C.O.D. is relatively inde-

pendent of the initial concentration of either solids or C.O.D. when the reactor temperature is above 500 F. Thus the higher the original C.O.D., the greater is the percentage removal of C.O.D.

Reaction Rate as Function of Temperature and Time—For each oxidation temperature there's a certain rate of oxygen absorption as seen from Fig. 3. At low temperatures several hours are required to reach equilibrium. But at 572 F. (300 C.) the reaction is almost instantaneous.

Conditions in Reactor's Vapor Space—The relationship of reactor temperature to total reactor pressure is given in Fig. 4. The ratio of pounds of steam per pound of dry air that can exist at reactor conditions is plotted.

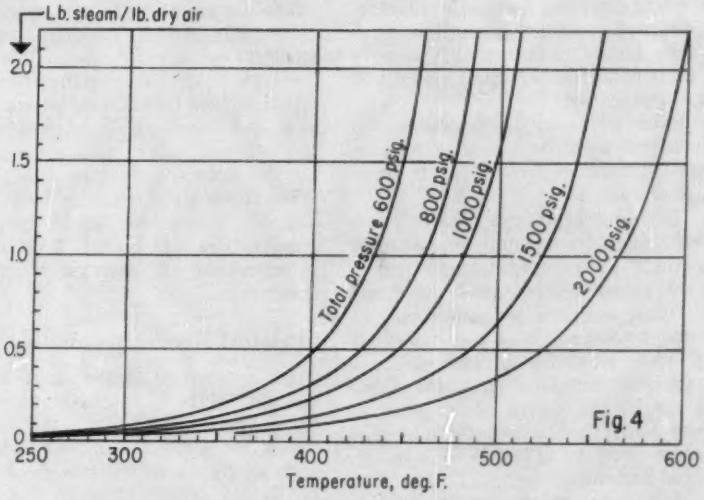
With the aid of this graph the quantity of liquid water remaining in the reactor can be calculated. The temperature in the reactor is the temperature of saturated steam (read from steam tables) at the partial pressure of steam in the gas-steam mixture.

If a reactor operates at 553 F. and 1,500 psig. there can be 2.0 lb. steam/lb. dry air in the vapor space at saturation. A waste with 5% solids contains about 8 lb. water/gal. waste. If all the water is vaporized in the presence of air in this reactor so that the gas-steam mixture were just saturated, 8/2 = 4 lb. air/gal. waste would be required.

Therefore to maintain liquid water in the reactor the maximum fuel (waste) concentration in the feed should not be greater than that which would require 3-3½ lb. air/gal. waste.

More than 4 lb. air/gal. waste would cause all the water to evaporate which would stop the oxidation. If the system gets heat from an outside source—as a preheater—even less air per gallon can be used unless the feed solution is diluted with water.

Steam-Air Ratio Determines Reactor Conditions



Waste Materials Have Heating Values as High as Other Fuels

	Heating Value	Oxidant Required for Complete Combustion		Heating Value
	Btu./Lb. Material	Lb. O_2/Lb. Material	Lb. Air/Lb. Material	Btu./Lb. Air
Fuel Materials:				
Hydrogen	61,000	7.94	34.34	1,780
Ethylene	21,460	3.42	14.8	1,450
Carbon	14,093	2.66	11.53	1,220
Oxalic acid	1,203	0.18	0.77	1,565
Fuel oil	19,376	3.26	14.0	1,380
Lactose	7,100	1.13	4.87	1,455
Waste Materials:				
Waste sulfite liquor solids	7,900	1.32	5.70	1,385
Semichemical pulp solids	5,812	0.96	4.13	1,410
Primary sewage sludge	7,820	1.33	5.75	1,365
Activated sewage sludge	6,540	1.19	5.14	1,270

Wastes Serve as Good Fuels

Fuels release heat only when they are burned with an oxidant—usually air. Though air is proverbially free, it's just as important as fuel in combustion. But when the fuel is free—as in the case of industrial or municipal wastes—and air costs money because it must be compressed, there's a new concept of fuel economics.

In our process we must get just the right proportion of air to fuel into the reactor to obtain the most efficient combustion conditions.

The table above shows an interesting relation between fuel quantity and the required amount of oxidant. The first column is the conventional manner of reporting fuel heating values.

The last column rates the heating value on the basis of Btu./lb. air required for total fuel combustion. Most of the ordinary fuels have almost equal heating value on this basis (about 1,400 Btu./lb. air). Waste materials's average heating value is 1,358 Btu./lb. air.

If C.O.D. is assumed equal to the oxygen required to oxidize wastes in a liquor, the amount of air required and the resulting combustion heat can be calculated by: (1) A = C.O.D./27.8 and (2) H.V. = 1,358 × A = 48.8 (C.O.D.), where A = air supplied, lb. air/gal. waste liquor; C.O.D. = chemical oxygen demand, gm. O_2/liter waste liquor; H.V. = heating value, Btu./gal. waste liquor.

For example a waste sulfite liquor containing 140 gm./liter C.O.D. requires 5 lb. air/gal. waste to completely oxidize the fuel, and the combustion liberates 6,830 Btu./gal. waste.

Process Recovers Useful Power

In Rothschild a power cycle has been operated with soda base paper mill effluent as fuel. Liquor is oxidized in a reactor two feet in diameter and 20 feet high. Exit gases

are superheated by the oxidation of unburned organic compounds in a platinum-filled catalytic reactor. The gases expand through a two-stage piston engine which powers an air compressor, liquor pump and d.c. generator.

Even with our inefficient equipment, 14 kwh. in excess of process needs were generated at 3 gpm. liquor rate.

Turbines of course recover process energy from compressed reactor gases in large operations. To prevent steam condensation in steam turbines exit reactor gases may be superheated.

When maximum process steam is required, complete oxidation takes place in the liquid phase reactor, and superheat is supplied by flue gases from an external coal- or oil-fired furnace.

If it's desired to not use outside fuels and/or to reduce the size of the liquid phase reactor, the oxidizer can be operated with a lower holding time. When only partial oxidation occurs in the reactor, organic gases are liberated with steam and stack gases.

These organic gases are oxidized in a gas phase reactor with silver or platinum catalyst. The second oxidation takes place in the absence of liquid water, and all the heat generated raises the gas temperature.

The degree of volatility (organic compounds which vaporize when heated) varies with each type of fuel. In some paper mill effluents 8-10% of the C.O.D. can be volatilized, and some go as high as 15-20%—much more than necessary for the second oxidation step.

We've obtained temperatures 360 deg. F. above the liquid reactor temperature, but only 110-130 deg. F. superheat will keep gases dry in the turbine.

Chemical Recovery—A Bonus

In a semichemical paper mill, sodium sulfite is the main cooking liquor ingredient. Thus the spent liquor for disposal contains sodium salts of lignin sulfonic acid. After the liquor passes through the wet oxidation unit, lignin sulfonic acid is oxidized to sodium sulfate, which can be converted to sodium sulfite.

We've proved this process in a small commercial plant, and we've developed chemical recovery processes for almost all pulping liquors.

Another long-used recovery system in the pulping industry is the Kraft process. Black liquor is concentrated in multiple-effect evaporators to a solids content of 50-60%. The concentrate is poured onto a bed of live coals and burned, and the soda salts flow from the bottom of the firebox as a smelt.

Some of the steam from the concentrate-burning boiler evaporates the water from the feed liquor before the concentrate is ready to burn in the firebox. At the very high firebox temperatures large quantities of soda salts are volatilized, producing the well-known Kraft furnace smokestack plume.

In a wet oxidation unit black liquor is oxidized in a closed reactor at a temperature of 570 F.—about 1,430 deg. F. lower than the Kraft furnace. Chemical loss is thereby eliminated.

A wet oxidation pilot plant has produced 50% more net process steam after satisfying all power requirements than a conventional Kraft operation.

The cooking chemicals are recovered by adding barium sulfide and calcium oxide to the oxidation plant effluent. The resultant calcium carbonate and barium sulfate are converted in one calcining operation to calcium oxide and barium sulfide.

Major Commercial Installations

A wet oxidation unit has been in operation at the Southwest Works of the Metropolitan Sanitary District of Greater Chicago for several months. This unit treats about 2 ton/day of sewage sludge (dry basis), which is equivalent to the primary treatment plant's sludge in a city of 40,000 people.

The reactor operates at 1,200 psig. and 500 F. The process does not require outside power or heat when the feed concentration is at least 80 gm./liter C.O.D. (about 6-7% solids).

When the C.O.D. is reduced by 70-80%, the effluent deposits its insoluble constituents (sand and ash) rapidly and virtually free of solid organic matter.

The largest wet air oxidation plant so far is being built in Norway for the Borregaard Paper Co., and should start operating late this year or early next year.

This unit will oxidize all the waste sulfite liquor from a 500 ton/day pulp mill, the largest in Norway. The waste liquor will first be fermented and will come to the process from the alcohol stills at 220 F.

Two reactors of the type pictured above will operate in parallel. Each is 60 ft. high and has a 6-ft. diameter. The air compressor is a rotary unit which compresses atmospheric air to 2,250 psig. The maximum reactor temperature will be about 590-600 F.

Residual effluent removes calcium sulfate from the system and contacts incoming air countercurrently in a humidifier. Exit reactor gases pass through an alkaline scrubber to remove acids present. The gases give up their heat content to produce process steam in several reboilers or evaporators.

Maximum steam pressure developed is 700 psig. This steam passes through a turbine coupled directly to the air compressor. Similarly noncondensable gases, CO_2 and N_2 pass through a gas turbine connected on the same shaft. The process requires no outside power.

The purpose of this plant is to furnish 236,000 lb./hr. of process steam for plant use at 120-150 psig. Some low-pressure steam for paper drying also results from the unit.

Mainly of European construction, the Norwegian plant will cost about $4 million. It's being built to eliminate the need of importing fuel oil.

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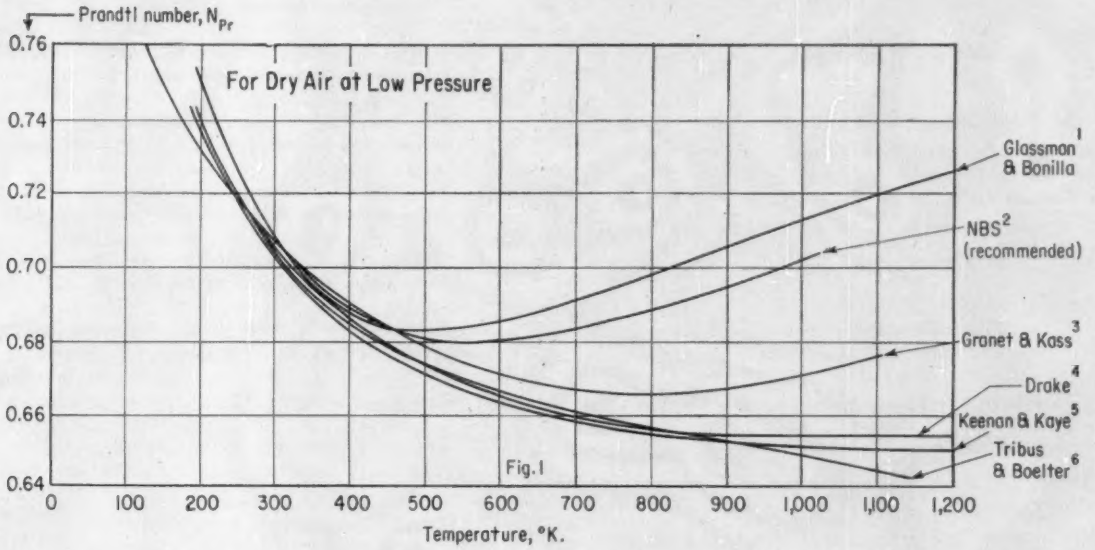

Even for simple gases experimental values are uncertain. Theoretical approaches are lacking. For engineering use, here are today's . . .

Best Methods for Prandtl Number

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PRANDTL number assembles into one group three important engineering properties of a fluid: heat capacity, viscosity and thermal conductivity. Usually it is defined as:

$$N_{Pr} = c_p\mu/k$$

For engineering applications an understanding of Prandtl number and its use in heat-transfer analogies may help solve many unusual problems. In this article we evaluate methods for estimating N_{Pr} for gases, gas mixtures and liquids. Also, for use in convective mass-transfer calculations, we'll discuss how to estimate the Schmidt number, N_{Sc}.

Gases: A Two-Fold Range

At low or moderate densities, the Prandtl numbers of gases and vapors over broad ranges of temperatures vary from about 0.6 to 1.2, a two-fold range.

With increase of temperature at constant low pressure, N_{Pr} of a gas often decreases, reaches a minimum and then increases. The accuracy of Prandtl numbers is limited primarily by available values of thermal conductivity; but any uncertainty is decreased by the fractional exponents of N_{Pr} when it is used in heat-transfer calculations.

Fig. 1 gives you some idea of the uncertainties connected with N_{Pr} values in engineering use today. Here we've shown six sets of recommended data for dry air at low pressure from 100-1,200 K. Between 200-500 K., the maximum spread of N_{Pr} is $\leqq 3\%$, but the spread increases with temperature, reaching about 13% at 1,200 K.

Tentatively we recommend that you use the NBS curve.

No realistic rigorous and theoretical approach to the calculation of gas N_{Pr} has been proposed. This is due primarily to the theoretical difficulties involved in treating the internal forms of energy possessed by polyatomic molecules.

However, a number of empirical and semi-theoretical rules have been proposed. Many of these equations are presented in the literature in relatively unfamiliar terms, such as "the ratio of the mean free paths for diffusion and viscosity," and "the reduced dimensionless coefficient of diffusion." All of these equations may, however, be reduced to a simple form:

$$(N_{Pr})_{1,T} = \phi\,(c_{pM})_{1,T} \qquad (1)$$

In Table I we have reduced six proposals to the form of Eq. (1), and Fig. 2 plots the six equations of Table I as N_{Pr} vs. c_{pM}, where c_{pM} is molar heat capacity at constant pressure.

We've selected the relatively recent—and apparently reliable—compilations of Bromley, [7] Vines

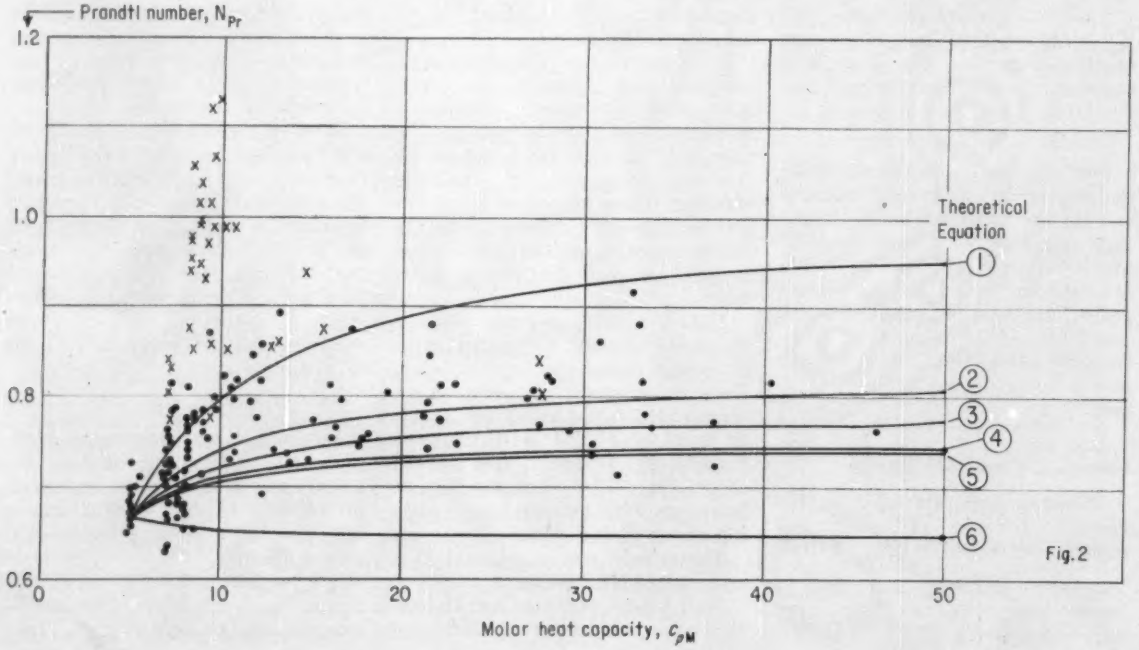
*Mr. Gambill is now with the Union Carbide Nuclear Co., Oak Ridge, Tenn. To meet your author, see *Chem. Eng.* Feb. 10, 1958, p. 173.

Theoretical Approaches to Prandtl Numbers for Gases—Table I

Number	Origin	Equation	Basis	Reference
1.	Eucken	$N_{Pr} = \frac{c_{pM}}{c_{pM} + 2.48}$	Empirical. Based on early data. Later rederived semi-theoretically.	7, 8
2.	Hilsenrath & Touloukian	$N_{Pr} = \frac{c_{pM}}{1.204\ c_{pM} + 1.47}$	Semi-theoretical. Based on the Bernoulli smooth, elastic sphere model.	2, 9
3.	Hirschfelder	$N_{Pr} = \frac{c_{pM}}{1.27\ c_{pM} + 1.137}$	Semi-theoretical. Constants based on data of Vines and Bennett, Ref. 11.	10
4.	Knuth	$N_{Pr} = \frac{c_{pM}}{1.32\ c_{pM} + 0.894}$	Semi-theoretical. Based on the Lennard-Jones attraction-repulsion model.	12
5.	Hirschfelder	$N_{Pr} = \frac{c_{pM}}{1.328\ c_{pM} + 0.856}$	Semi-theoretical. Based on the Lennard-Jones attraction-repulsion model.	10
6.	Hilsenrath & Touloukian	$N_{Pr} = \frac{c_{pM}}{1.55\ c_{pM} - 0.238}$	Semi-theoretical. Based on the Maxwell repulsion model.	2, 9

Experimental Data Sources for Values of Prandtl Number—Table II

Source	Monatomic Gases	Monatomic Points	Highly Polar Gases	Highly Polar Points	Linear Nonpolar Gases	Linear Nonpolar Points	Nonlinear Nonpolar Gases	Nonlinear Nonpolar Points	Notes	Ref.
Bromley	4	8	10	14	12	21	19	35	Data selected at lowest and highest tabulated temperatures. Over-all temp. range of 32–1,832 F. c_p data from Kobe, μ and k data from Bromley.	13, 16
Vines & Bennett	0	0	4	5	0	0	13	13	Data selected at highest tabulated temp. Range of 176–320 F. c_p from $c_v^\circ + R$.	11
Keyes	0	0	1	5	8	15	1	2	Data selected at 0 C. min. temp. and at highest listed temperature.	14
Drake	0	0	2	6	3	9	0	0	Data selected at lowest, half-between and highest listed temperatures.	4
Granet & Kass	0	0	1	3	4	16	0	0	Values chosen at lowest, highest and two intermediate temps. Range of 0–1,500 F.	15
Hilsenrath & Touloukian	2	6	1	3	7	21	0	0	Values chosen at lowest, half-between and highest listed temps. Range of 100–1,500 K. Molar c_p obtained from companion NBS paper byMasi.	2, 17
Over-all	4	14	12	36	12	82	22	50	Over-all temperature range of 70–1,900 K.	—



& Bennett,[11] Keyes,[16] Drake,[4] Granet & Kass [15] and Hilsenrath & Touloukian [9] for comparisons with the proposed empirical equations. Table II shows the extent and type of experimental data that are available.

Since it is very difficult—if not impossible—to select the "best" values on the basis of the published results outlined in Table II, we have plotted all these data and the six empirical curves derived from Table I as Fig. 2.

Looking at Fig. 2, we can make the following comments:

- Curve 6 definitely doesn't represent the data; and recently proposed curves 3, 4 and 5 underestimate N_{Pr}.
- For $c_{pM} > 15$, the old smooth-sphere model (Curve 2) probably strikes the best average, about ± 15% maximum error.
- For $c_{pM} < 15$, the much-used and oft-quoted Eucken approximation (Curve 1) tends to represent the data somewhat better than the other relations. Excluding H_2O and NH_3, the maximum deviation is about ± 15%.
- The points for monatomic gases cluster closely about the theoretical point ($N_{Pr} = 2/3$; $c_{pM} = 5$), as expected.
- Polar gases exhibit larger-than-normal Prandtl numbers at a given heat capacity. The group of points at the upper left of Fig. 2 are for steam and NH_3 only. Points for other polar gases are best represented by the Eucken relation (Curve 1). This is to be expected since the theories on which Curves 2-6 were based are not applicable to polar compounds.

To Use a Simple Average

Arithmetic average for all Prandtl numbers on Fig. 2 is 0.78, to within + 45% and −24%. This is probably a larger error range than you might wish to deal with. Use of a reasonably accurate range of N_{Pr} values necessitates that gases be classified according to their type.

Many schemes, both qualitative and quantitative, for characterizing gases and liquids have been proposed.[19] We've adopted the simple system used by Bromley, [18] wherein gases are treated as monatomics, highly polar, linear nonpolar and nonlinear nonpolar. (By "linear" we mean those gases whose structural formulas can be written in a straight line. These are mostly diatomic and triatomic gases.)

Here's how we have classified the 50 gases included in this particular study:

Monatomic—A, He, Ne, Xe

Highly Polar—Methanol, ethanol, *n*-propanol, isopropanol, steam, NH_3, SO_2, H_2S, HBr, HCl, acetaldehyde and acetonitrile.

Linear Nonpolar—N_2O, NO, N_2, O_2, H_2, F_2, Cl_2, Air, C_2H_2 CO, CO_2 and CS_2.

Nonlinear Nonpolar—CH_4, C_2H_6, C_3H_8, *n*-butane, isobutane, *n*-pentane, *n*-hexane, cyclohexane, acetone, C_6H_6, CCl_4, $CHCl_3$, methyl acetate, ethyl acetate, Freon-12, diethyl ether, C_2H_4, CH_3Cl, CH_2Cl_2, ethyl chloride, thiophene and uranium hexafluoride.

For these 50 gases, we have found these over-all averages.

Monatomic—$N_{Pr} = 0.67 \pm 5\%$ max. error, based on 14 points for four gases.

Linear Nonpolar—$N_{Pr} = 0.73 \pm 15\%$ max error, based on 82 points for 12 gases.

Nonlinear Nonpolar—$N_{Pr} = 0.79 \pm 15\%$ max. error, based on 50 points for 22 gases.

Highly Polar—$N_{Pr} = 0.86 \pm 8\%$ max. error, based on 15 points excluding steam and ammonia. For steam and ammonia $N_{Pr} = 1.0 \pm 10\%$ max. error, based on 21 data points.

By using these simple averages we get probable errors that are no larger than those associated with the best of the equations in Table I. Therefore, our tentative recommendation is that the averages given above be used; or that you use Eq. (1) of Table I for $c_{pM} < 15$ and Eq. (2) of Table I for $c_{pM} > 15$.

Effect of Pressure

Though N_{Pr} of gases is usually stated to be independent of pressure over moderate ranges, high pressure can considerably increase the magnitude of N_{Pr} at low reduced temperatures. Three related procedures are available for calculating the pressure dependence of Prandtl number.

If sufficient data are available, the most accurate approach is probably through Enskog's equation of state:[20]

$$P + a\rho^2 = \frac{RT\rho}{M}(1 + b\rho x) \qquad (2)$$

which may be manipulated[21] to give the following:

$$\frac{(N_{Pr})_{P,T}}{(N_{Pr})_{1,T}} = \frac{(c_p)_{P,T}}{(c_p)_{1,T}} \times \frac{1 + 0.8\,b\rho x + 0.7614\,(b\rho x)^2}{1 + 1.2\,b\rho x + 0.7574\,(b\rho x)^2} \qquad (3)$$

Also, it has been shown[22] that $(b\rho x)$, which may be treated as a single variable, may be calculated from:

$$b\rho x = \frac{M\,(\partial P/\partial T)_\rho}{R\rho} - 1 \qquad (4)$$

However, this method requires good P-V-T data for success.

Probably the best quick line of attack is to evaluate the ratios $(c_p)_P/(c_p)_1$, μ_P/μ_1, and k_P/k_1 from generalized correlations treated in other parts of this series of articles. (This method substitutes generalized graphical correlations of c_p, μ and k for the analytical correlation and associated *P-V-T* data of the method described above.)

The ratios are then applied as correction factors to an experimental or calculated low-pressure value of N_{Pr}, as follows:

$$\frac{(N_{Pr})_{P,T}}{(N_{Pr})_{1,T}} = \frac{[(c_p)_{P,T} - (c_p)_{1,T}] + (c_p)_{1,T}}{(c_p)_{1,T}} \times (\mu_{P,T}/\mu_{1,T}) \times (k_{1,T}/k_{P,T}) \qquad (5)$$

Another proposal[23] suggests that a generalized correlation of the N_{Pr} ratio should have this form:

$$\frac{(N_{Pr})_{P,T}}{(N_{Pr})_{1,T}} = \phi(T_r, P_r, c_{pM1}) \qquad (6)$$

Comings and Nathan[23] presented an approximate graphical correlation of the N_{Pr} ratio, omitting consideration of c_{pM1}, to indicate the trend of variation of N_{Pr} with pressure. This plot is cited for illustrative purposes only. It should not be used in specific calculations except for rough estimates. The important information to be gained from this plot is that for reduced temperatures of 1.0 to 1.3, N_{Pr} increases considerably with pressure increase.

Values for N_{Pr} of steam at high pressures, based on various sets of experimental data for c_p, μ and k, cover a broad range and are not in very good agreement. This is probably due mostly to the uncertainty connected with values for steam viscosity.

Rubin[24] has presented a graph of N_{Pr} vs. P and T for steam that shows a maximum value of $N_{Pr} = 5.3$ (for saturated steam at 2,000 psi.) This maximum value was

questioned by Devore,[25] and National Bur. of Standards values[26] are generally about ½ smaller than Rubin's values. The uncertainty of high-pressure μ and k values for steam makes this difference difficult to resolve at the present time.

Methods for Gas Mixtures

Prandtl numbers of nonreacting gas mixtures may be considerably different from values of Prandtl numbers for the pure components. The procedure of weighting known or calculated values of c_p, μ and k by methods dealt with elsewhere in this series is probably better than trying to average N_{Pr} values of the components.

For a mixture of gases in chemical equilibrium, the effective specific heat and thermal conductivity can be as much as an order-of-magnitude larger than c_p and k of a gas mixture of the same composition but with no chemical reaction between components (usually called the "frozen" state of the gas mixture). There is no corresponding increase of viscosity because of chemical reaction, however.

It has been pointed out[27, 28] that to a good first approximation, N_{Pr} is also unchanged by reaction, since

$$(k_e/k_f) \cong (c_{pe}/c_{pf}) \qquad (7)$$

where the subscript e indicates the equilibrium state; and subscript f indicates the "frozen" state.

Consequently, for the case of equilibrium gaseous systems, one can use the usual Prandtl numbers in heat transfer calculations for nonreacting gases, provided one uses the true equilibrium specific heat in the Stanton number or equilibrium thermal conductivity in the Nusselt number.

Values for Liquids

For the commonly encountered liquids, N_{Pr} ranges from about 2.0 (water and some light organics) to 20,000 (heavy oils). For liquid metals, N_{Pr} is very small, varying from 0.003 for K to 0.07 for Li. N_{Pr} of fused salts[29] are normal, ranging from 1 to 6 for NaOH; HTS; and mixtures of LiCl-KCl; and of LiF-NaF-KF.

An empirical relation between N_{Pr} and the latent heat of vaporization was noted by Denbigh[30] for common di-electric liquids. The correlation may be put in this form:

For organic liquids,

$$\log N_{Pr} = (L_V/17.87\ T) - 1.80 \qquad (8)$$

For water only,

$$\log N_{Pr} = (L_V/19.52\ T) - 2.20 \qquad (9)$$

Data for water from 10 to 80 C. fit Eq. (9) with a 2.0% avg. error and a 3.0% max. deviation. Eq. (8) represents the mean line through 31 data points for 27 liquids of various kinds (but excluding water) for the 20- to 70 C.-temperature range. For these substances the average and maximum prediction errors are 30% and 104%.

The accuracy would probably be better if a different set of numerical constants were used for each chemical class, since the hydrocarbons tend to have Prandtl numbers greater than predicted; and the hydroxylic compounds smaller-than-predicted Prandtl numbers.

Since the accuracy of Eq. (8) is not good, it should be used only for rough estimates. If experimental liquid viscosity data are available, N_{Pr} may be estimated more accurately by calculating c_p and k using methods described elsewhere in this series.

Values for the Prandtl numbers of specific liquids are given in a table by Drake[31] and in a nomograph by McAdams.[32]

About Schmidt Number

The dimensionless Schmidt number, $\mu/\rho D$, is important in many convective mass-transfer situations. N_{Sc} varies at least 12-fold for gaseous systems under common conditions (considerably more than the variation of N_{Pr} of gases).

This writer[33] has shown that N_{Sc} of binary gas mixtures with one component in low concentration may be estimated simply from:

$$N_{Sc} = \frac{0.445\ TM_B^{0.5}(V_A^{0.33}+V_B^{0.33})^2}{(T+1.47T_{bA})(M_A+M_B)^{0.5}V_A^{0.67}} \qquad (10)$$

where A and B are the two components; M is molecular weight; V is molecular volume at T_b in cc./gram-mole; T_b is normal boiling point, deg. K; and T is absolute temperature, deg. K.

For steam, NH_3, O_2, H_2 and 15 organic vapors, all in air at 273 K. and 1 atm. abs., calculated values checked experimental results with avg. and max. deviations of 7.8% and 16.0%. Eq. (10) is limited to low or moderate pressure and about 400 F. maximum temperature. For correction to binary mixtures of any composition (where one of the components is not necessarily in low concentration), and for a discussion of the general case, see Ref. 33.

No correlation has been proposed for N_{Sc} of liquids, probably because of the absence of an accurate general relation for calculating the viscosity of a liquid at a given condition from other property data.

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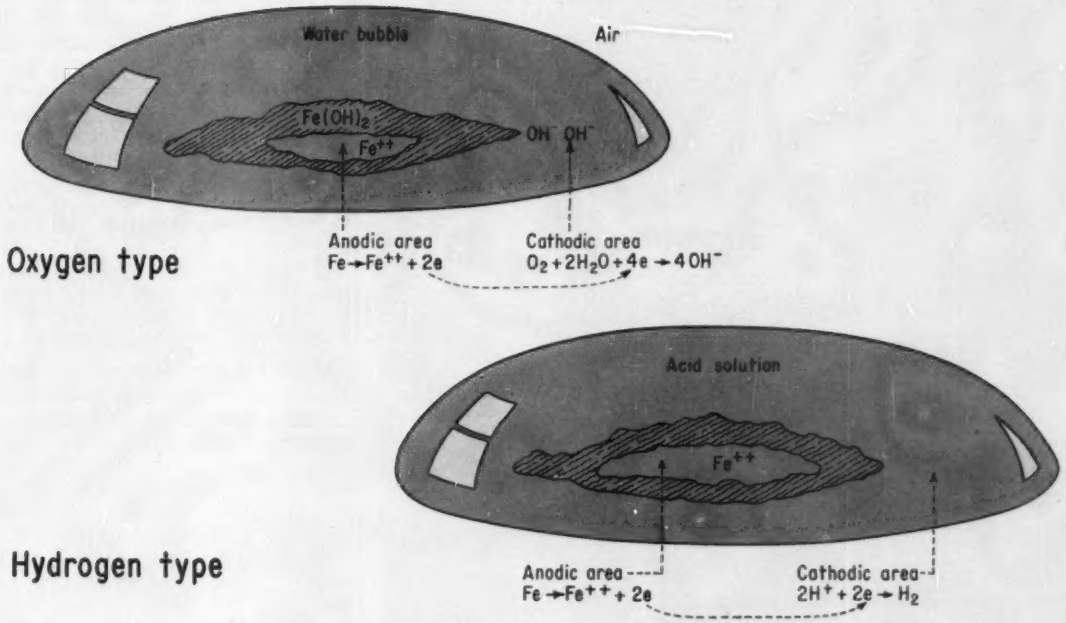

How Oxidative Corrosion Occurs

In this installment, the author reviews the fundamental principles of electrochemical corrosion and shows how these apply to practical corrosion chemistry and to patterns of attack.

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In the majority of cases that the chemical engineer encounters, corrosion proceeds via an electrochemical mechanism. In this type of attack, countless local galvanic couples form on the surface of a corroding metal in which the metal is spontaneously oxidized and some substance is reduced.

Each couple is actually a small battery and the corrosion reaction proceeds with a flow of electric current between anodic and cathodic sites on the metal. The process is governed by the same laws of electrochemistry that apply to electroplating, electrowinning of metals and the functioning of batteries.

On another page in this article, we review these fundamental principles of electrochemistry. Here, we'll consider the application of these principles to oxidative corrosion. Although numerous modifying factors produce varied patterns of attack, the chemical fundamentals are the same.

The basic requirements are always: (a) differences in potential between adjacent areas on an exposed metallic surface to provide anodes and cathodes; (b) moisture to provide an electrolyte; (c) a corroding agent to be reduced at the cathode and (d) an electrical path in the metal for electron flow from anodes to cathodes.

At the anodes on a corroding surface the metal is oxidized to positive ions. With iron the reaction is simply:

$$Fe = Fe^{++} + 2e \qquad (1)$$

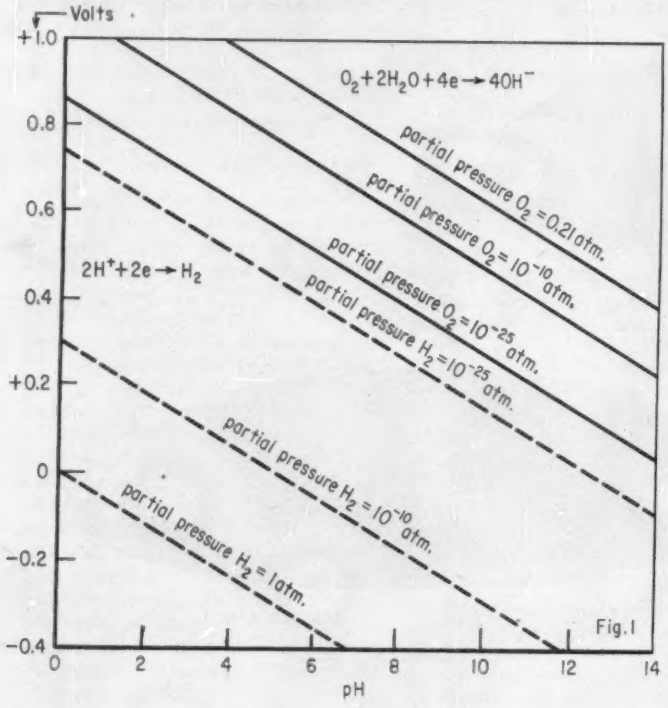
As the metal ions move away from the surface, they encounter hydroxyl ions in the surrounding electrolyte and form precipitates of corrosion products. With iron the initial precipitate is usually ferrous hydroxide and the over-all anode reaction is then

$$Fe + 2OH^- = Fe(OH)_2 + 2e \qquad (2)$$

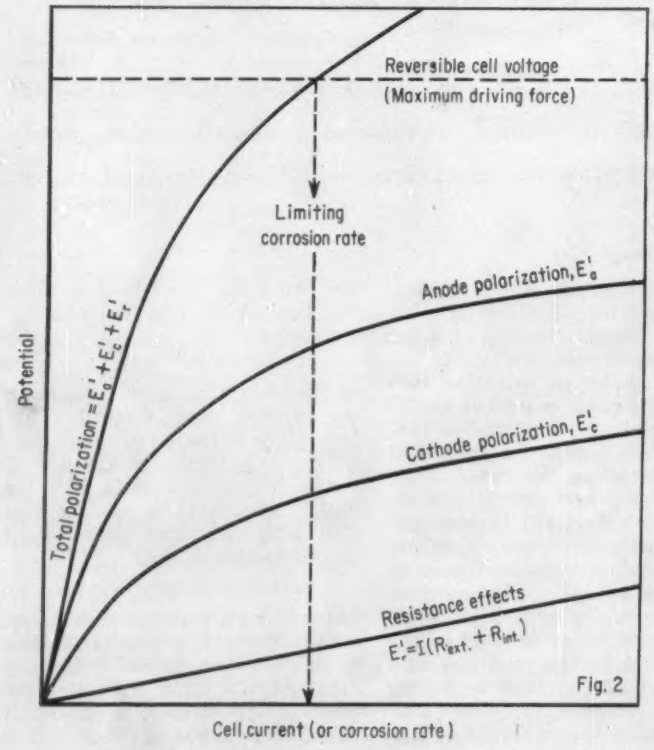
Depending on exposure conditions, the precipitate is gradually oxidized to ferric hydroxide and eventually dehydrated to the iron oxides commonly found in rust. These latter reactions need not be considered as

*To meet your author, see *Chem. Eng.*, July 28, 1958, p. 161.

How to Compare Spontaneity of Cathode Reactions



Conditions Necessary to Establish Anodic Control



part of the electrochemical mechanism.

At the cathodes, several reduction reactions are possible. The one which actually takes place is determined by environmental conditions. In the absence of air, hydrogen evolution occurs. This attack known as hydrogen-type corrosion takes place by one of these reactions:

$$2H^+ + 2e = H_2(g) \quad (3)$$
$$2H_2O + 2e = H_2(g) + 2OH^- \quad (4)$$

In acid media, Reaction (3) predominates.

When air is present, the reduction of oxygen is more spontaneous than hydrogen evolution. Several reactions are possible, namely:

$$O_2 + 4H^+ + 4e = 2H_2O \quad (5)$$

Galvanic Series*
Anodic end
- Magnesium
- Zinc
- Alclad 3S
- Aluminum 3S
- Aluminum 61S
- Aluminum 63S
- Aluminum 52
- Low steel
- Alloy steel
- Cast iron
- Stainless steels (active)
  - Type 410
  - Type 430
  - Type 304
  - Type 316
- Ni-resist
- Muntz metal
- Yellow brass
- Admiralty brass
- Aluminum brass
- Red brass
- Copper
- Aluminum bronze
- Composition G bronze
- 90/10 Copper-nickel
- 70 + 30 Copper-nickel-low iron
- 70 + 30 Copper-nickel-high iron
- Nickel
- Inconel
- Silver
- Stainless steels (passive)
  - Type 410
  - Type 430
  - Type 304
  - Type 316
- Monel
- Hastelloy C.
- Titanium

Cathodic end

*This galvanic series[7] is for metals and alloys in sea water.

$$O_2 + 2H_2O + 4e = 4OH^- \quad (6)$$
$$O_2 + 2H_2O + 2e = H_2O_2 + 2OH^- \quad (7)$$

Ordinarily Reaction (7) does not occur to any appreciable extent and so Reactions (5) and (6) are of principal concern in oxygen-type corrosion. Under acid conditions, Reaction (5) predominates and in neutral or alkaline environments, Reaction (6) is dominant.

We may predict the relative spontaneity of possible cathode reactions by taking appropriate potential values from Table I and calculating cell potentials for prevailing conditions of pH and oxygen concentration. The results of this procedure for Reactions (3) and (6) are shown in Fig. 1. Note that oxygen-type corrosion is fundamentally more spontaneous than hydrogen-type at all values of pH—even when gas partial pressures are very low.

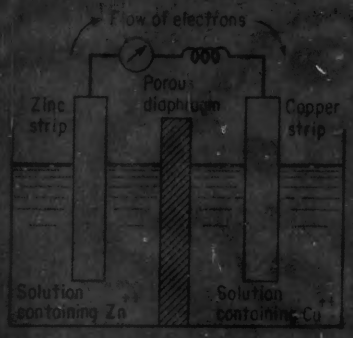
This same approach can be used to predict relative tendencies of different metals to corrode in known environments. Unfortunately, such predictions do not always correlate with results obtained in actual practice. Since corrosion like all chemical reactions is a rate process, we can not predicate rates by thermodynamics.

While we may know the driving force as measured by potential in a corrosion cell, we can not predict with equal certainty rate-determining resisting effects such as polarization in a given environment. Our knowledge of polarization factors is not yet sufficiently quantitative to permit precise calculation of corrosion kinetics.

Until this knowledge becomes available, we must rely on accumulated qualitative experience with different enviroments in selecting corrosion-resistant materials. Thus a galvanic series is of more practical value to the corrosion engineer than the standard electromotive series derived from experimental laboratory data. Further information[8] on galvanic series may be found in the references.

In general, we know that polarization in any galvanic cell increases as current flow between anode and cathode increases and that corrosion rate is directly proportional to cell current. Thus a limiting or steady-state corrosion rate as shown in Fig. 2 is attained when total polarization or counter-voltage equals the reversible cell potential. Proper measures taken

Review Electrochemical Theory



To understand corrosion by the electrochemical mechanism, we shall review briefly the general principles of galvanic cells. As an example, it is helpful to consider a typical galvanic cell in which an oxidation-reduction reaction takes place spontaneously. Such a system is the familiar Daniell cell shown above. The total reaction of this cell expresses the displacement of cupric ions from solution by metallic zinc as the cell generates electric current.

$$Zn(s) + Cu(aq)^{++} = Zn(aq)^{++} + Cu(s) \quad (A)$$

The reaction shown in Eq. (A) is actually the sum of two electrode reactions. Oxidation of zinc metal:

$$Zn(s) = Zn(aq)^{++} + 2e \quad (B)$$

Reduction of cupric ions:

$$Cu(aq)^{++} + 2e = Cu(s) \quad (C)$$

To understand the Daniell cell, Eqs. (B) and (C) are essential because they show the chemical action taking place at each of the electrodes. Further, these equations explain why the reaction can not proceed unless the copper and zinc strips are connected electrically. The electrical connection provides a path for electrons to travel from the zinc strip where they are generated to the copper strip where they are consumed.

The electrode at which oxidation (generation of electrons) takes place is called the anode. The electrode at which reduction (consumption of electrons) takes place is the cathode.

These definitions apply to all electro-chemical cells whether energy is generated or consumed. Also, these definitions avoid the ambiguity in designating anodes and cathodes by electrical signs. Therefore, in the Daniell cell, the zinc strip is the anode and the copper strip is the cathode.

Since the electrode reactions proceed with the liberation of energy, we say the cell is spontaneous. Hence, the Daniell cell may be used as a source of electric current. When connected as a battery, the copper electrode is the positive terminal and a potential exists between the copper and zinc.

If it were possible to withdraw electricity from a galvanic cell reversibly at constant temperature and pressure, maximum work is performed. Under these conditions the electrical energy delivered is equal to the thermodynamic free energy change in the cell. To calculate free energy, we use the following equation:

$$\Delta F = -nFE \quad (D)$$

where ΔF = increase in free energy of the cell; n = number of electrons involved in the cell reaction per atom of reactant; F = Faraday's constant (96,500 columbs/gram-equivalent) and E = reversible (or equilibrium) cell voltage.

Note that Eq. (D) shows cell voltage is proportional to the liberated energy. Cell potential is then a measure of the tendency of the reaction to take place, or of the driving force behind the cell reaction. The larger the driving force, the more spontaneous[1,2,3] is the cell.

Since the total reaction in a galvanic cell is actually the sum of two electrode reactions, it is proper to consider the total voltage as the sum of two half-cell potentials. These are characteristic of the oxidation reaction at the anode and the reduction reaction at the cathode. Likewise, the total energy change in the cell is the sum of the energy changes in the two half-cells and Eq. (D) applies to each of the electrode reactions.

Systematic experimental measurement of half-cell reactions leads to a compilation of data such as Table I. Provided the specified reaction conditions are maintained, each of the half-cells exerts the characteristic potential listed in the table when combined with a second half-cell to complete an oxidation-reduction pair.

Total standard voltage of a given cell is then simply the sum of the two appropriate single electrode potentials. Discussion of experimental techniques for measuring cell potentials is not appropriate here, but may be found in most textbooks on physical chemistry or electrochemistry[1,2,4].

In Table I the reactions for simple oxidation of metals to form positive ions and electrons are listed in the order of the well known electromotive series. A given metal will displace from aqueous solution the ions of any metal below it in the series. The lower its position in the series, the more

noble (or less readily oxidized) is the metal; the higher its position, the more anodic (more easily oxidized).

Units of Standard Potentials

In using the data in Table I, we must remember certain inherent conventions and standard conditions. First, note that each of the reactions is written as an oxidation. Thus the potential for each reactant is an oxidation potential representing the tendency of the substance to be oxidized to a more positive valence state by loss of electrons. The corresponding reduction potential for the reverse reaction (gain of electrons) is numerically equal to the value shown in Table I but of opposite sign.

For example, for the oxidation of copper:

$$Cu = Cu^{++} + 2e \quad E^0 = -0.345 \text{ volt}$$

For the corresponding reduction:

$$Cu^{++} + 2e = Cu \quad E^0 = 0.345 \text{ volt}$$

Second, the arbitrary standard to which all other electrode potentials are related is the half-cell reaction:

$$H_2 \text{ (gas, 1 atm.)} = 2H^+ \text{ (aq., 1 M)} + 2e$$

By universal agreement, a value of zero is assigned to the potential of this reaction. In actual measurement, the half-cell consists of a noble metal electrode surface which is usually platinum covered with platinum black. The electrode is saturated with hydrogen gas at one atmosphere pressure and immersed in a solution of hydrogen ions at an active concentration of one mole per liter.

In Table I, the potentials of oxidation reactions more spontaneous (anodic) than the standard hydrogen electrode are written as positive. Those less spontaneous (cathodic) are written as negative. This notation is consistent with the conventions adopted by the American Chemical Society and most American journals.

Third, there are specific reaction conditons associated with the potential values listed in Table I. Temperature is 25 C. All effective ion concentrations are one molar. Gases are at one atmosphere pressure. Under these conditions, the half-cell potential for any reaction is the standard value listed in the table. A few exceptions to these conditions are noted in the table.

Concentration Effects

The effects of concentration changes on cell potential can be deduced qualitatively from mass action principles. Hence, reducing reactant concentrations or increasing product concentrations causes all potentials to decrease. Thus the voltage of a battery such as the Daniell cell runs-down with use.

As current is withdrawn from the cell, the concentration of zinc ions increases and that of cupric ions decreases. These changes cause a continual decrease of cell potential. This principle applies as well to each of the half-cells in a galvanic couple as to the total cell reaction.

Quantitative treatment of these changes can be handled by the generalized expression[4,5,6]

$$E = E^0 - \frac{RT}{nF} \times \ln \frac{\text{(Product of resultant activities)}}{\text{(Product of reactant activities)}} \quad \text{(E)}$$

For most practical purposes, activity can be replaced by concentration C. For the typical galvanic cell reaction, $aA + bB = gG + hH$, Eq. (E) becomes:

$$E = E^0 - \frac{RT}{nF} \ln \frac{(C_G)^g (C_H)^h}{(C_A)^a (C_B)^b} \quad \text{(F)}$$

Usually solid concentrations are substantially constant and are taken as unity. Therefore ion concentrations and gas partial pressures are of primary interest in applying Eq. (F) to cell calculations.

For use at 25 C with common logarithms, Eq. (F) simplifies to

$$E = E^0 - \frac{0.0591}{n} \log \frac{(C_G)^g (C_H)^h}{(C_A)^a (C_B)^b} \quad \text{(G)}$$

Concentration differences between two solutions of the same ion may be used to form a cell with two like but opposite electrode reactions. Such an arrangement is known as a concentration cell. This principle forms the basis for electrochemical measurement of ion concentrations.

A familiar example is found in hydrogen ion concentration cells for measuring pH. In actual practice, solution concentration effects can even change the relative positions of metals in the electromotive series. When ion concentrations are known, such shifts are predictable by using Eq. (F).

The Gibbs-Helmholtz relationship[4] provides a basis for calculating the effect of temperature on cell potential. This equation is:

$$\Delta F = \Delta H + T\left[\frac{\partial (\Delta F)}{\partial T}\right]_p \quad \text{(H)}$$

Substituting Eq. (D) into Eq. (H) gives:

$$-nFE = \Delta H - TnF\,(\partial E/\partial T)_p \quad \text{(I)}$$

We use Eq. (I) to calculate enthalpy change ΔH for cell reactions from measured values of $\partial E/\partial T$. However, we can rearrange Eq. (I) into the following form:

$$\left(\frac{\partial E}{\partial T}\right)_p = \frac{\Delta H + nFE}{nFT} \quad \text{(J)}$$

When ΔH for the reaction is known, we can use Eq. (J) to calculate change in potential as a function of temperature. However, its use is restricted to small temperature changes since average values must be used for ΔH, E and T. For large changes, experimental measurement of temperature effects is preferable.

Throughout this discussion, we have stressed that maximum cell voltage occurs only under reversible conditions where the cell reaction is actually at a standstill. In the laboratory, this condition is attained in cell measurements at zero current by means of a potentiometer.

What Is Polarization?

In actual practice as soon as current is allowed to flow through the cell; the chemical equilibrium is disturbed and irreversible effects occur. These reduce the efficiency of energy conversion and cause a drop in cell voltage. The difference between the maximum or theoretical cell potential and the actual working voltage is called polarization. It is expressed as a potential.

$$E' = E_{theor.} - E_{actual} \quad \text{(K)}$$

Polarization potential is analogous to a counter-electromotive force in mechanical equipment used to generate electricity.

Polarization potential E' is a measure of irreversibility and varies with cell current. When the practical objective is efficient conversion from chemical to electrical energy as in a battery or vice-versa as in electroplating, it is important to minimize polarization. However, in electrochemical corrosion a high degree of polarization is desirable because it slows down the rate of attack. Many corrosion control measures are aimed at increasing polarization of galvanic couples.

Causes of Polarization

The several effects that contribute to cell polarization fall into four categories: (a) circuit resistance, (b) concentration polarization, (c) surface film resistance and (d) overvoltage. Their relative importance in determining the total polarization varies from one cell to another.

Two types of circuit resistance exist, internal and external. They may be considered separately. The electrolyte between the anode and cathode will have some electrical resistance R_i depending on the types of ions present, their concentrations and cell geometry. If a diaphragm is present in the cell, its resistance is included in R_i.

In terms of equivalent voltage drop, the contribution of internal resistance is calculated from Ohm's law $E_i' = IR_i$ where I represents the current. Similarly the voltage dissipated against external circuit resistance is $E_e' = I(R_i + R_e)$. Its contribution to total cell polarization is usually small but don't overlook its effect.

Each of the remaining three polarization effects may result from cathode or anode phenomena or both. In a given cell the two electrodes are considered separately under these categories. However, general principles and mechanisms are common to both anode and cathod polarization effects.

Concentration polarization results from concentration gradients in the cell electrolyte. At each electrode, the prevailing potential is determined by ion concentrations in the solution immediately adjacent to the electrode. This concentration must be different from that in the bulk of the solution, because ions must diffuse to or from the electrode as the cell reaction proceeds. The magnitude of the resulting concentration gradient in each case depends on ion mobilities and on the current, tending to be larger as current increases.

At the surface of the anode where ions are formed, their concentration is higher than in the bulk solution; at the cathode where ions are discharged, it is lower. In either case, as can be seen from Eq. (E), a lowering of electrode potential results thus causing polarization.

The presence of a surface film on an electrode obviously impedes galvanic action. It separates the metal from the electrolyte and retards both flow of electricity and diffusion of ions. The more non-porous and adherent the film, the more pronounced its polarizing effect. Even porous, loosely adhering films can cause substantial polarization. Some electrode processes tend to form films, and in such cases the magnitude of film polarization increases as the reaction proceeds. In electrochemical corrosion, naturally formed and artificial films play important roles in corrosion control.

Influence of Overvoltage

Overvoltage is the term applied to irreversible effects that can not be clearly attributed to concentration polarization or film formation. Usually a slow step in the kinetics of the electrode reaction is responsible.[4] Hence, overvoltage is a rather specific phenomenon varying in magnitude with the reaction involved. Overvoltages are often large in reactions involving gases and usually quite small in reactions involving only metals and ions.

Gas overvoltages are higher on smooth surfaces than on rough. Overvoltage generally decreases with increased temperature. It increases rapidly with current density at low values of current, but tends toward a maximum at higher values.[5] Additives such as gelatin and glue increase overvoltage. This effect is useful in corrosion control and in some electroplating applications where prevention of gas discharge is desirable.

to increase polarization reduce the value of the limiting rate.

In order to choose the most effective method to reduce corrosion by increasing polarization, it is important to know whether a particular system is under anodic or cathodic control. We must know whether anode or cathode polarization effects predominate in determining total polarization. In Fig. 2, we illustrate anodic control, with anode polarization substantially greater than cathode polarization.

In this type of system an anodic inhibitor, serving further to impede anode processes, is much more effective in controlling corrosion than a cathodic inhibitor. Similarly, a system under cathodic control is best controlled with a cathodic inhibitor. Indeed, use of an anodic inhibitor in a cathodic system can lead to acceleration of corrosion.

Precipitated films of corrosion products serve as natural polarizers. Their effect is small when these films are porous and nonadherent. However, when a thin, impervious and adherent film is formed, it may polarize a surface completely and prevent further attack. This condition is known as passivity.

Aluminum, chromium, nickel, tin and stainless steels form oxide films spontaneously in many environments rendering them passive. Iron and certain of its alloys can be made passive by treating-processes which create impervious oxide coatings. Lead resists corrosion by sulfuric acid because of an insoluble lead sulfate film. Passivating films may be destroyed by changing the environment—for example, aluminum corrodes in sea water and hydrochloric acid attacks stainless steels.

Oxidation Potentials, Table I

Electrode Reaction	E_0 Volt
$K = K^+ + e$	2.922
$Ca = Ca^{++} + 2e$	2.87
$Na = Na^+ + e$	2.712
$Mg + 2OH^- = Mg(OH)_2(s) + 2e$	2.67
$Mg = Mg^{++} + 2e$	2.34
$Al + 3OH^- = Al(OH)_3(s) + 3e$	2.31
$Al = Al^{+++} + 3e$	1.67
$Cr + 3OH^- = Cr(OH)_3(s) + 3e$	1.30
$Zn + 2OH^- = Zn(OH)_2(s) + 2e$	1.245
$Mn = Mn^{++} + 2e$	1.05
$Fe + 2OH^- = Fe(OH)_2(s) + 2e$	0.877
$H_2(g) + 2OH^- = 2H_2O + 2e$	0.828
$Zn = Zn^{++} + 2e$	0.762
$Fe + CO_3^{--} = FeCO_3(s) + 2e$	0.755
$Fe + 3OH^- = Fe(OH)_3(s) + 3e$	0.73
$Cr = Cr^{+++} + 3e$	0.71
$Fe = Fe^{++} + 2e$	0.440
$H_2(g) = 2H^+(10^{-7}\text{mol/l.}) + 2e$	0.414
$Pb + SO_4^{--} = PbSO_4(s) + 2e$	0.355
$Ni = Ni^{++} + 2e$	0.250
$Cu + 2OH^- = Cu(OH)_2(s) + 2e$	0.224
$Sn = Sn^{++} + 2e$	0.136
$Pb = Pb^{++} + 2e$	0.126
$Fe = Fe^{+++} + 3e$	0.036
$H_2(g) = 2H^+ + 2e$	0
$Cu = Cu^{++} + 2e$	−0.345
$4OH^- = O_2(g) + 2H_2O + 4e$	−0.401
$4OH^- = O_2(g, p=0.21\text{ atm.}) + 2H_2O + 4e$	−0.391
$Cu = Cu^+ + e$	−0.522
$2H_2O = O_2(g) + 4H^+(10^{-7}\text{ mol/l.}) + 4e$	−0.815
$2H_2O = O_2(g) + 4H^+ + 4e$	−1.229
$2Cl^- = Cl_2(g) + 2e$	−1.42
$2F^- = F_2(g) + 2e$	−2.85

Standard states are gas pressure at 1 atm., temperature at 25 C. and effective ion concentrations at 1 molar except as shown.

Where Does Corrosion Occur?

It is difficult to predict precisely the location of anodic and cathodic areas on a metal surface. Generally, anodic areas occur where (a) the metal is highly strained or rough, (b) oxygen concentration is low, (c) a protective film has been broken (d) impurities cathodic to the metal are present or (e) the metal is in electrical contact with another more cathodic metal. Conversely, cathodic areas may be expected for opposite conditions.

Localized intensity of attack is determined by relative proportions of anodic and cathodic areas. When these are approximately equal, corrosion is uniform over the whole exposed surface. However, when cathodes markedly outnumber anodes, attack at each anode location is quite intense with resulting pitting and eventually perforation failure. This condition often exists at points of breakdown in a protective coating which is cathodic to the base metal, notably at cracks or pinholes in tin or chromium plating on steel.

Bi-metallic corrosion may cause costly failures when dissimilar metals are connected electrically and exposed to corrosive conditions. The less noble metal becomes anode and the more noble cathode. The

Concentration Cell Develops at Riveted Joint

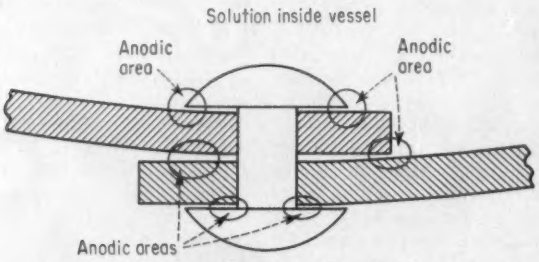


Fig. 3

result is accelerated corrosion of the less noble metal. The greater the separation between the metals in the galvanic series, the greater the corrosion potential.

Corrosion is especially rapid and intense if the cathode to anode area ratio is large such as for steel bolts in a copper plate. Therefore, avoid bi-metallic couples whenever possible in equipment construction. When they can not be eliminated or the metals insulated from each other, choose materials close together in the galvanic series and make the smaller part of the nobler metal.

Concentration cell corrosion is important in chemical process equipment failure, since conditions favorable to its occurrence are often found in the handling of corrosive solutions. This type of attack, also called gasket corrosion or crevice corrosion, results when galvanic couples are formed by concentration differences in the environment at adjacent locations on a metal surface. These differences may be either in solution concentration or in aeration.

Both situations are shown in Fig. 3. Here, a riveted lap joint in a tank is under attack internally by a corroding solution and externally by the atmosphere. Inside the tank, metal ion concentration is considerably higher in the crevices under the rivet head and in the lap joint than in the bulk of the solution. Thus the area at the mouth of each crevice is relatively anodic. On the outside, the interior parts of the crevices are inaccessible to oxygen and are therefore anodic to the surrounding area which are better aerated.

Differential aeration also plays an important role in the intensification of pitting. As a pit grows deeper its bottom becomes less accessible to oxygen and consequently more anodic. If the pit is located at a break in a protective coating, corrosion spreads under the coating where basis metal is inaccessible to oxygen and therefore relatively anodic.

As the name implies, intergranular corrosion is localized attack at the grain boundries of a metal or alloy. They are known to be anodic to the surrounding grains, since this forms the basis for metallographic etching. Unstabilized stainless steels are especially susceptible to intergranular corrosion because of chromium carbide precipitation at the grain boundaries. In this type of attack, complete failure of the metal results even though only a small fraction of the total weight corrodes.

Stress corrosion is the general term applied to several patterns of attack in which stress is believed to accelerate corrosion. Stress corrosion includes simple stress corrosion, stress-corrosion cracking and corrosion fatigue. Stress corrosion often occurs when uniform corrosion is nearly negligible. To produce cracking, stress corrosion requires the presence of rather severe residual tensile stresses such as those resulting from cold working or improper welding.

With our present knowledge, it is not possible to predict how long a susceptible material will survive in a given environment, since the interrelations between temperature, corrosive environment, stress level and alloy compositions have not yet been clearly defined.

The most acceptable current theory[8] is that cracking results from electrochemical action between narrow paths of stress-caused anodic material and the more cathodic bulk surface. As corrosion proceeds, the tensile stresses open crevices exposing more anodic metal to attack.

Well-known examples of stress corrosion are caustic embrittlement of iron and steel and season-cracking of brass. Corrosion fatigue occurs when a metal is subjected to repeated reversals of stress in a corrosive medium. These stress reversals lead to uneven surface depressions or pits which eventually reduce the metal cross-section to the point of tensile failure.

Dezincification failure was originally observed on brasses from which zinc was selectively leached by corrosive environments. We now use the term to describe the general phenomenon of selective removal of one of the components of an alloy and thus leaving a weakened structure. Graphitization of cast iron is in this category. Here iron is corroded away, leaving a weak graphite network.

Increasing the flow rate of a corrosive liquid past a metal surface generally increases corrosion rate. Corrosion products and protective films are swept away. At high velocities a type of attack called erosion-corrosion results. It is a combination of mechanical wear and corrosion and is characterized by smoothly formed interconnected pits. The presence of abrasive materials in the fluid intensifies this attack. Pipe, fittings, agitators and pumps are examples of process equipment which are affected by erosion-corrosion.

Cavitation-erosion, a special case of erosion-corrosion, occurs in highly turbulent flow where vapor cavities are formed in the liquid. T. P. May[8] presents a discussion of velocity effects in corrosion studies.

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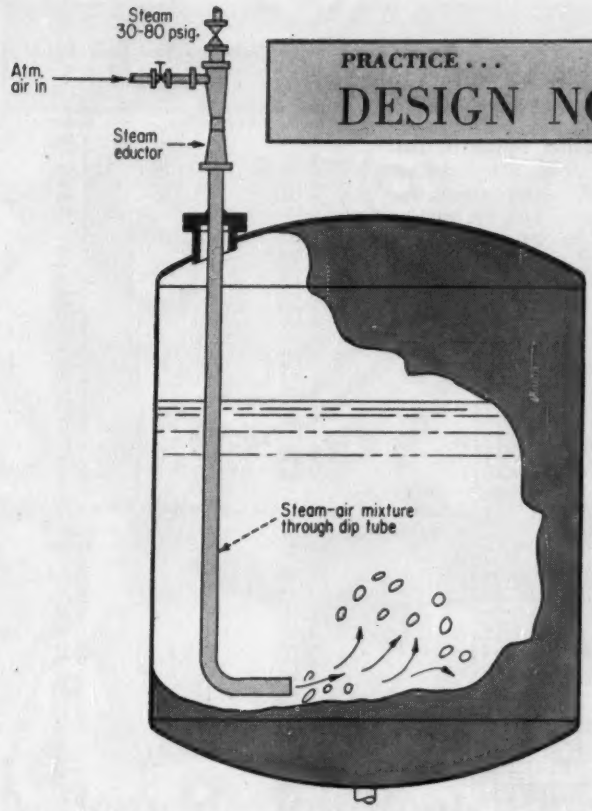


NEXT ISSUE:

See July Winner Announcement

★ How Readers Can Win

$50 Prize for a Good Idea—Until further notice the Editors of *Chemical Engineering* will award $50 each four weeks to the author of the best short article received during that period and accepted for Plant or Design Notebook.

Each period's winner will be announced in the second following issue and published in the third or fourth following issue.

$100 Annual Prize—At the end of each year the period winners will be rejudged and the year's best awarded an additional $100 prize.

How to Enter Contest—Any reader (except a McGraw-Hill employee) may submit as many contest entries as he wishes. Acceptable material must be previously unpublished and should be short, preferably not over 500 words, but illustrated if possible. Acceptable non-winning articles will be published at space rates ($10 minimum).

Articles should interest chemical engineers in development, design or production. They may deal with useful methods, data, calculations. Address Plant & Design Notebooks, *Chemical Engineering*, 330 W. 42nd St., New York 36, N. Y.

Eductor Cuts Noise of Live Steam Heating

Blowing live steam into a liquid is noisy and may produce serious vibration. Here's a new way to decrease the noise.

★ Winner of the Mid-Summer Contest by
Javier F. Kuong

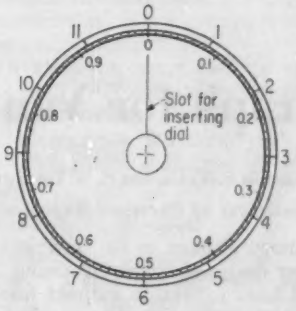
Process Engineer, Atlas Powder Co., Wilmington, Del.

When a process vessel lacks a heating jacket or coil, it is common practice to blow live steam into the vessel contents by means of a dip pipe or sparger. This practice is noisy due to the sudden collapse of the condensing steam bubbles, and may set up severe vibrations.

Consequently, there are various so-called noiseless heaters on the market and many engineers have devised their own. These generally depend on some method of inducing a rapid flow of liquid past the point of entering steam and producing an intimate steam-liquid mixture.

The diagram shows a simple way of cutting the noise and vibration, operating on a principle different than that usually employed. It also avoids the need for immersing some form of noiseless heater. The idea is to use the energy of the entering steam to induce a flow of atmospheric air which mixes with the steam in a simple steam eductor. The eductor is connected into the steam dip pipe, with the side inlet open to the atmosphere. The air that mixes with the steam reduces the partial pressure of the latter and the non-condensible air exerts a cushioning action on the collapsing steam bubbles.

The effect is a substantial reduction in both noise and vibration. Of course, this method cannot be used where either direct steam or air cannot be allowed to contact the process liquid. But it is particularly useful where both heating and air sparging are desired.



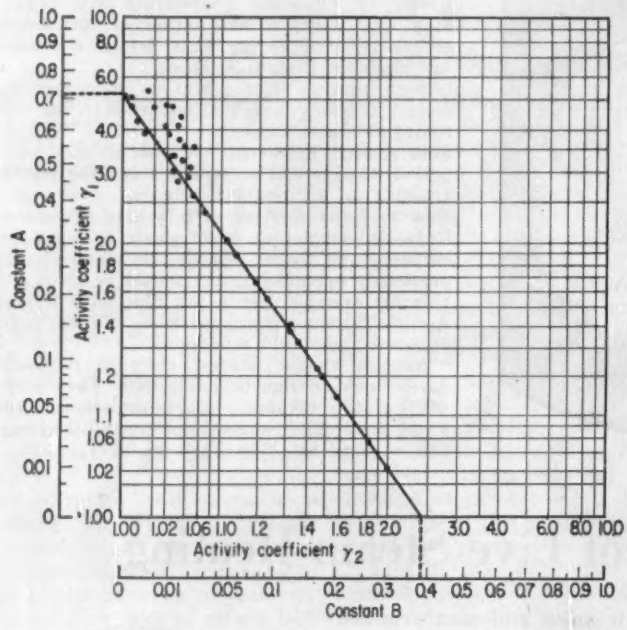
Read Time Direct in Decimal Units

H. J. Ramey, Jr.
Project Engineer, General Petroleum Corp., Santa Fe Springs, Calif.

Many experiments and routine tests of transient processes—and even some steady-state processes—require data observation at timed intervals. It has become second nature to us to measure time in hours, minutes and seconds, but

decimal parts of an hour are often more convenient and we can waste considerable time in making the conversion.

The diagram shows a decimal clock dial which we drew on bond paper and glued to the face of a standard 9-in. wall clock. Divisions of the outer circle remain the same but the inner circle is divided into units of 0.01 hr. The dial can be read to 0.01 hr., and 0.005 hr. estimated. Note that the second hand no longer has significance since one revolution equals 0.0167 hr. Note also that the reading accuracy is now better since the smallest division is 0.01 hr. rather than the 0.0167 hr. of the conventional clock.



Plotting Data for Van Laar Paper

Gamma Scales

Linear Scales	γ_1 and γ_2 Scales
0	1.00
0.066	1.01
0.093	1.02
0.130	1.04
0.159	1.06
0.183	1.08
0.203	1.10
0.282	1.20
0.338	1.30
0.382	1.40
0.420	1.50
0.452	1.60
0.480	1.70
0.505	1.80
0.528	1.90
0.548	2.00
0.631	2.50
0.691	3.00
0.778	4.00
0.836	5.00
0.882	6.00
0.919	7.00
0.950	8.00
0.977	9.00
1.000	10.00

Van Laar Constants Scales

Linear Scales	A and B Scales
0	0
0.071	0.005
0.100	0.01
0.142	0.02
0.173	0.03
0.200	0.04
0.223	0.05
0.245	0.06
0.265	0.07
0.283	0.08
0.316	0.10
0.387	0.15
0.447	0.20
0.500	0.25
0.547	0.30
0.592	0.35
0.632	0.40
0.671	0.45
0.707	0.50
0.742	0.55
0.775	0.60
0.806	0.65
0.837	0.70
0.866	0.75
0.894	0.80
0.922	0.85
0.948	0.90
0.975	0.95
1.000	1.00

Graph for Van Laar Constants

Benjamin C.-Y. Lu and B. A. Lavergne

Department of Chemical Engineering, University of Ottawa, Ottawa, Canada.

Shown above is a new graph paper designed for determining the Van Laar constants without taking logarithms or square roots. Values of γ_1 and γ_2 are plotted directly and the values of A and B obtained without any further calculation.

The Van Laar equations as rearranged by Carlson and Colburn:[1]

$$\log \gamma_1 = \frac{A}{\left(1 + \frac{A\,x_1}{B\,x_2}\right)^2} \qquad (1)$$

$$\log \gamma_2 = \frac{B}{\left(1 + \frac{B\,x_2}{A\,x_1}\right)^2} \qquad (2)$$

are useful for fitting and smoothing binary vapor-liquid equilibrium data. In Eqs. (1) and (2) the γ's refer to activity coefficients, x refers to liquid mole fraction, A and B are constants and the subscripts refer to components.

Factors x_1 and x_2 can be eliminated from these equations to give:

$$(\log \gamma_1)^{1/2} = A^{1/2} - (A/B)^{1/2}(\log \gamma_2)^{1/2} \qquad (3)$$

A similar equation was proposed by Snedeker.[3] With the equation, evaluation of the Van Laar constants can be carried out by plotting the square root of log γ_1 vs. the square root of log γ_2. The intercept obtained is $A^{1/2}$ and the slope, $(A/B)^{1/2}$.

The new graph paper can be constructed from the tabulation by plotting the values of γ_1, γ_2, A and B against the equivalent values in terms of linear coordinates. The γ's are then plotted directly. For example, the points shown are for the ethanol-water system at atmospheric pressure, using activity coefficients as reported by Otsuki and Williams.[2] The plot gives emphasis to points corresponding to liquid mole fractions of ethanol between 0.1 and 0.9. Drawing the best straight line, we find from the intercepts opposite the A and B scales that $A = 0.72$ and $B = 0.39$. Values reported in Ref. (2) are $A = 0.720$ and $B = 0.392$.

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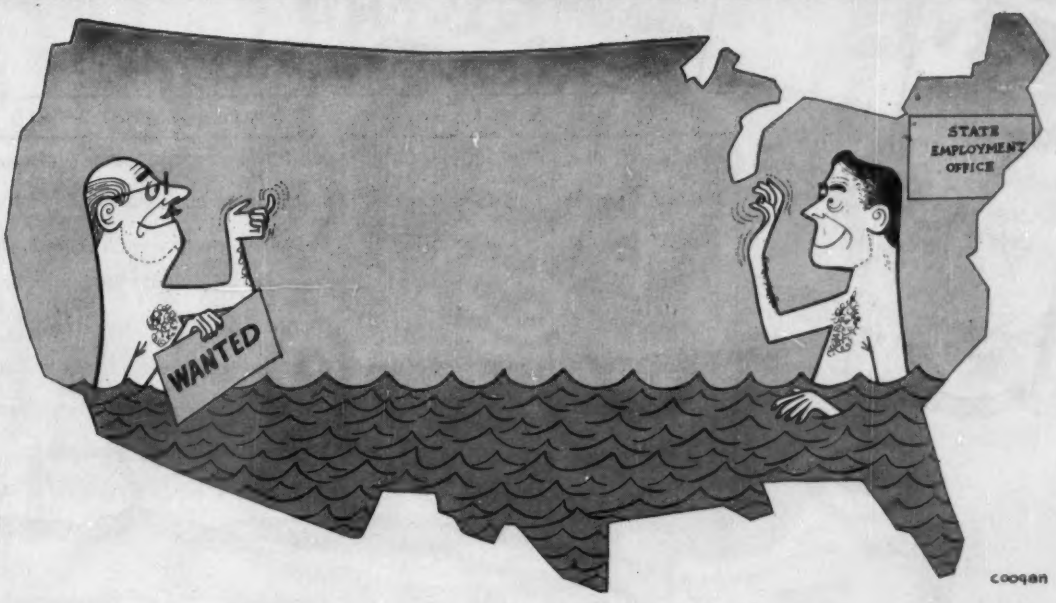

Nationwide Job Pools Place Professionals

Originally created to help employers combat the "shortage," this free service is now helping engineers find jobs in these days of temporary overabundance.

By completing a single application form and preparing one resume you can now look for a job in 78 locations at the same time. Even more helpful, employers throughout the nation who may be looking for engineers may have access to your qualifications within 48 hours after you file them with your local state employment office.

In successful operation since the end of last year, the professional placement network maintained by the U. S. Bureau of Employment Security and the various state employment security agencies is supplying a much-needed service to professional employees and to their employers, as well.

Here's how the system works.

Matching People and Positions

As in the past, job seekers file applications at their nearest local employment office (job seekers need not be unemployed). Also, employers continue to place their job orders with the local office serving the communities in which their establishments are located.

Local offices which have not been designated as professional network centers forward job applications in the professional and managerial field that cannot be matched with local job orders to the State's central employment security office.

Here, the state office not only compiles its own biweekly state inventory of job openings, but also maintains a file of other state inventories. Local offices are advised of the locations of appropriate job openings.

This part of the system has been in operation for many years. The new operation is this: Each state office, in making up its state inventory of job openings, is now generating a separate list of the job openings in the professional occupations. Copies of these state inventories are sent directly to each of the 78 professional network offices. Put together, these lists become a national inventory of job opportunities in professional and managerial occupations.

To give you some idea of size, the Oct. 1957 inventory showed 7,000 professional and managerial job openings which could not be filled from local community labor supplies.

Stations on the Network

Professional offices along the network match people with positions on the nationwide inventory. (See sample orders, next page.) The advantages of having professional offices do the matching are myriad to jobseekers and employers alike. Specialists are assigned the task of screening applicants and job orders.

For example, in the New York City professional office there is a separate engineering and science unit. Within this unit there is an employment counselor who specializes in chemists and chemical engineers.

Not all the professional offices

YOU & YOUR JOB . . .

Title	Rate of Pay	Special Job Information
Chemist, organic	$500-900 Mo. & Up	3722 Ph D chemistry w/exper. w/polymers & monomers. Phys organic trng helpful. Work w/plastic compounds & associated materials used in design & development of rockets & missiles. Sec. check. X cal 059-26-M.
Chemist, organic	$550-600 Mo.	2911 BS, MS, or Ph D chemistry & 5 yrs. experience in detergents recently. Ph D. conduct
Professor, assistant College or University	$6000-9000 for 9 mos a year	
Professor, assistant College or University	$6000-900 for 9 mos a year	

State Inventory of Job Openings — April 23 – May 6, 1958 — Page 2 of 9

Metallurgist, Phys.	$10,000-18,000 yr.	Deg.; 10 yrs. mgm. exp.; nuclear or alum. exp.
Engineer, Chemical	$100-140 wk.	Rubber coated fabric exp; tire cord fabric
Engineer, Chemical	$7000-7600 yr.	ME or Chem. exp. proj. wk.; prod. dev. mech.
Engineer, Chemical	$435 month	Deg.; heat transfer & fluid flow analy.; trainee
Engineer, Chem.	$7500-9500 yr.	Pilot plant hd.; polyurethane exp.
Engineer, Chem.	$10,000-15,000 yr.	Ph.D. Chem. or Metallurgy; nuclear reactor exp.
Engineer, Chem.	$7000-7500 yr.	MS pref. hydrocarbons or plastics; rec. grad.
Engineer, Chem.	$450 month	Degree; research for antibiotic mfg.
Engineer, Elect.	$7500 year	EE deg.; 2 yrs. design & research; 26-45

can hope to have such specialists. However, listed below are the state offices that are participating in the professional network. The letters in parentheses after a city indicate the type of office: (S) state office; (C & P) commercial and professional; (P & C) professional and clerical; (P) professional; (C) commercial.

Birmingham (S), Ala.; Juneau, Alaska; Phoenix, Tuscon, Ariz.; Little Rock, Ark.

Los Angeles, San Francisco. Calif.; Denver, Colo.; Hartford (S), Conn.

Wilmington, Del.; Washington, D. C.; Miami (C), Fla.; Atlanta (C & P), Ga.

Boise, Idaho; Chicago (C & P) Ill.; Indianapolis, Ind.; Des Moines (S) Iowa; Topeka (S), Kan.; Louisville, Ky.; New Orleans, La.

Augusta (S), Maine; Baltimore (P & C), Md.; Ann Arbor, Detroit (C & P), Hancock, Kalamazoo, Lansing, Mich.; Minneapolis, Minn.; Jackson (C & P), Miss.; Kansas City, St. Louis, Mo.; Billings, Mont.

Lincoln, Omaha, Nebr.; Las Vegas, Nev.; Concord (S), N. H.; Newark (C & P), N. J.; Albuquerque, Espanola, N. M.; Buffalo, New York City (P), Rochester, Syracuse, N. Y.; Charlotte, Durham, Greensboro, Winston-Salem, N. C.; Bismarck (S), N. D.

Cleveland, Ohio; Oklahoma City, Tulsa, Okla.; Portland, Ore.; Harrisburg, Philadelpia, Pittsburgh, Pa.; Providence, (S), R. I.; Charleston, S. C.; Aberdeen (S), S. D.; Memphis, Nashville, Tenn.; Houston, Texas.

Ogden, Provo, Salt Lake City, Utah; Montpelier (S), Vt.; Norfolk, Richmond, Roanoke, Va.; Seattle, Wash.; Charleston, Huntington, Morgantown, Parkersburg, Wheeling, W. Va.; Madison, Milwaukee, Wis.; Casper (S), Wyo.

Some Success Stories

Has the network been successful in matching jobs and people? Here are a few sample case histories supplied to us by the New York City professional office:

- Chemical engineer with 20 years of diversified experience referred and placed in Maryland as a result of job opening listed on the professional network.
- Chemist. New York applicant with a Ph. D. in physical chemistry referred and placed in a research and development laboratory in Pennsylvania.
- Mechanical engineer, a retired Lieutenant Commander employed as an instructor in a New York technical institute, was advised by his physician to move to a drier climate. Openings in New Mexico and Arizona were reviewed and resumes sent out. Applicant placed as an engineer in New Mexico.
- Tool design engineer, laid off from an aeronautical firm because of contract cutbacks, was referred and placed on opening listed by Connecticut state inventory of job openings for a gage designer. At time of interview in the New York City professional office, the applicant had sent out 50 resumes and had visited 15 firms but had received no job offers. Although he was reluctant to leave the city, a discussion of the local labor market conditions resulted in his willingness to explore out-of-state openings.

All Without Charge

As an individual engineer looking for a job, or as an employer of engineers looking for additional manpower, this free service for professionals and conducted by professionals in professional offices will speed up job matching.

The nationwide inventories are the key step in the process. These inventories of job openings, however, are for the use of employment service staffs only. Although they are not available outside the employment offices, applicants are often permitted to review selected inventories in the offices themselves.

ACKNOWLEGEMENT

Our thanks to Jean Landeau, Manager, Clarence Pope and Irving Guller of the Professional Office, N. Y. State Employment Service for their assistance.

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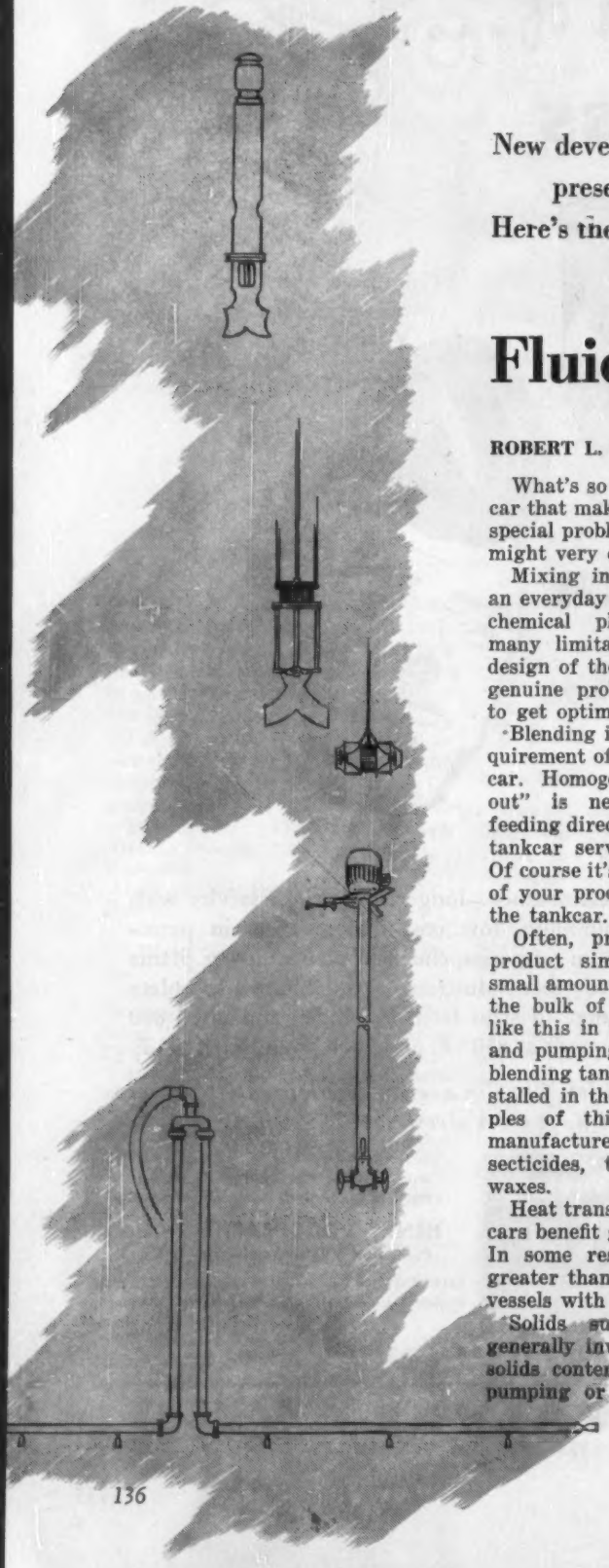

New developments in agitating liquids in tankcars present new possibilities for in-tank processing. Here's the lowdown on what to use and how.

Fluid Mixing in Tankcars

ROBERT L. BATES, Chemineer, Inc., Dayton, Ohio

What's so different about a tankcar that makes mixing fluids in it a special problem. At first glance you might very easily say nothing.

Mixing in a railroad tankcar is an everyday operation occurring in chemical plants. However, the many limitations imposed by the design of the tankcar makes this a genuine problem—if you're going to get optimum mixing.

Blending is the most common requirement of an agitator in a tankcar. Homogeneity before "pump-out" is necessary when you're feeding directly to a process and the tankcar serves as a storage tank. Of course it's desirable if all or part of your processing can be done in the tankcar.

Often, production of a liquid product simply means mixing a small amount of one ingredient into the bulk of another. Doing a job like this in the tankcar saves time and pumping costs. Most of all a blending tank doesn't have to be installed in the plant. Typical examples of this are found in the manufacture of industrial oils, insecticides, thinned tall oils and waxes.

Heat transfer operations in tankcars benefit greatly from agitation. In some respects, this benefit is greater than in vertical cylindrical vessels with coils or jackets.

Solids suspension applications generally involve slurries with low solids content and agitation helps pumping or guarantees a sample representative of the contents. In this category are latex, edible oils and saturated solutions of solids.

Dissolving of solids, so that soluble solids can be shipped in tankcars, has received much attention.[1] Direct mechanical agitation for this service is quite effective. For example, dissolving and melting sugar "in situ" is possible so that such crystalline solids can be shipped in tankcars. This greatly simplifies loading and handling procedures.

All of the problems peculiar to agitation in tankcars come from physical situations:

First is the vessel geometry; length to diameter (L/T) ratios average 5:1.

Second, the vessel position; always horizontal.

Third, and probably most serious, is the facility for installing a mixer. There's only one small manhole, located on the top center of the tank.

Last, the small matter of flexibility. Tankcars range from 6,000 to 10,000 gal. sizes but, there's little standardization of dimensions.

For a given capacity, several different diameters are available. Manhole openings may be anywhere from 14.5 to 18-in. dia.—with flange design "to suit."

There are two classes of mixers used for stationary installations of horizontal cylindrical tanks. These must be considered because of their adaptability to tankcars.

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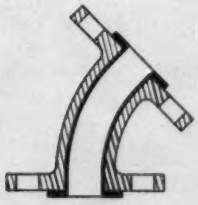
...with Teflon® at its best



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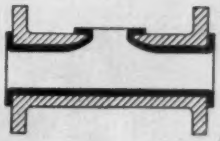
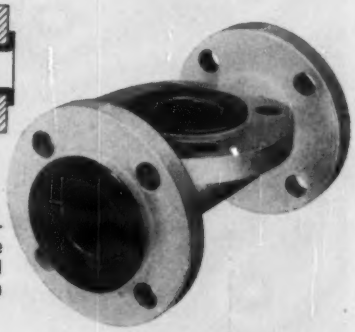
Smooth bends and seamless liner of special Teflon in elbows, tees and reducers mean a minimum of turbulence and disrupting back pressure.





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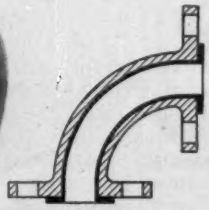

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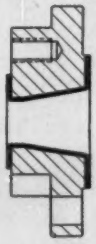
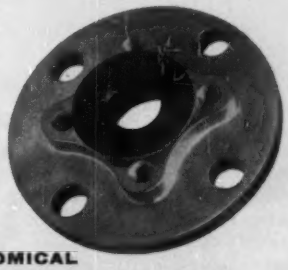
ASA short radius housings keep pipe runs compact, give tight turns in close quarters.





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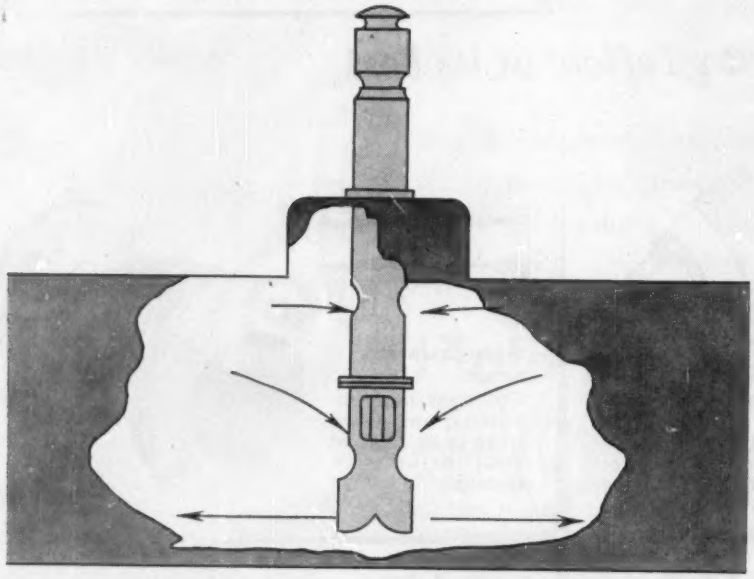
RESISTOFLEX *Complete systems for corrosive service*

TurboTube Agitator Develops Normal Flow Patterns



Side-entering propeller agitators can be installed on a nozzle on one end of the tankcar. But, this installation is permanent and requires a large investment for a small amount of service. Possibility of leakage from the submerged seal in transit can be disastrous.

Top-entering agitators, with radial discharging turbine impellers are used on horizontal cylindrical tanks. When the L/T ratio exceeds 2:1, multiple units must be used.

Applying a turbine agitator to a tankcar means the impeller must be smaller than normal, so that it can pass through the manhole. Then, to invest the required energy, it must turn at a much higher speed than normal. Result—an impeller design that's a high-head device and entirely unsuitable for applications requiring appreciable flow.

Approaches to the Problem

Jet mixing was the earliest approach to circulating liquids in tank cars and is still widely used. This equipment can be as simple as a bayonet tube. On the other hand it can be as complicated as a manifold extending the length of a car complete with eductor nozzles.

Air sparging is frequently used when the blending requirement is mild. Live steam injection serves the dual purpose of mild circulation and heating (provided the product isn't affected by it).

Liquid jet mixing, by recirculation with a pump, is the most common method. Horizontal arms feeding the eductors are supported from the dome cover and can be adjusted vertically for various liquid levels.

While jet mixing features low equipment cost, it's inefficient and ineffective and has little appeal to the chemical engineer.

Portable propeller agitators are the next highest on the cost scale and are effective blenders for low-viscosity fluids. Size ranges are from 1.5 to 3 hp.—shaft speed is usually 420 rpm.

As with any blending application, your choice of size and use of single or dual propellers is set by the fluid properties and the time available for blending.

Since flow from this type of mixer is unidirectional, the only way you can get a complete blend is by reversing the mounting position at least once during the operation. Because the agitator weighs between 175 and 250 lb., it isn't really portable. You must have a mechanical hoist as part of your installation.

Remember: this device is restricted to easy blending tasks. It doesn't give flow patterns complementary to the tank and isn't effective for solids suspension or any serious improvement in heat transfer.

Enter the TurboTube Agitator

Here is a top-entering design that uses a standard marine propeller to give a horizontal flow pattern in the tank. Using a propeller in a draft tube has been a common practice for many years, but always to give better vertical flow. This development[2] uses the tube to direct the fluid and adjust the ratio of flow to velocity head.

Propellers have been used for some time as no-head devices but, when placed in a draft tube and when an increase in velocity head is desired, its performance is drastically altered.

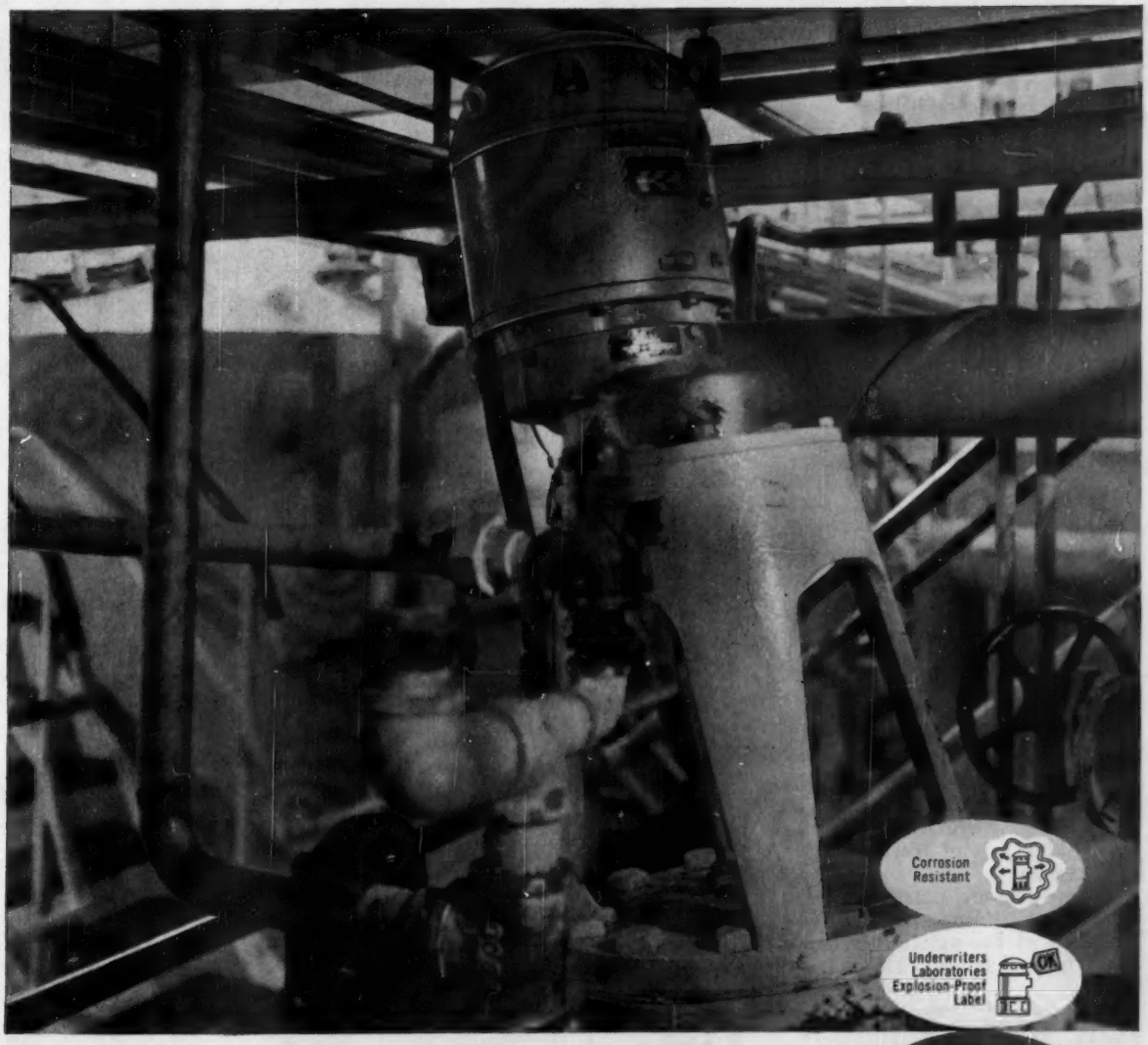
By encasing the propeller in a tube, its efficiency is improved since radial components are minimized and its performance approaches a true axial pump. On the other hand, a marine-type propeller is quite sensitive to any imposed head. Nominal increases in head cause the flow capacity to drop off sharply.

Observations of flow characteristics of a double-elbow, draft-bend style were made in a full-scale installation, using an 8,000 gal. tankcar. Agitation was by a 5-hp. motor with an 8-in. dia. square-pitch propeller running at 1,750 rpm.

Total discharge area of the draft bend was varied from 22 to 220% of the propeller throat area. Observations were made of discharge velocity, power, and velocity profiles at downstream sections of the tank. Data were analyzed to determine the ideal ratio of velocity to flow for the best over-all result. This was consistent, of course, with a reasonable power investment.

Fox and Gex's flux-of-momentum method[3] provided a striking way of correlating the data. Results sharply defined the optimum design point. With the total discharge area at 60% of the propeller throat area, the conditions of flow and turbulence are most evenly distributed throughout the tank.

By developing a natural flow pattern in the tankcar, the TurboTube blends with a minimum power investment. Since no stagnant areas occur, solids suspensions are produced and maintained.



This motor battles corrosion

Louis Allis explosion-proof chemical motors are ideal for chemical, petrochemical, plastics, and paint installations.

It takes a motor designed for the chemical industry to withstand the abuse of this corrosive service. The 2 hp totally-enclosed fan-cooled explosion-proof motor shown above on a mixer drive is typical.

Few applications are subjected to such extreme environmental conditions. To meet them, Louis Allis chemical motors are built with cast-iron housings to provide exceptional corrosion resistance to etching vapors and corrosive gases. Motor shrouds are stainless steel, fans are bronze. Even the nameplate is made of stainless steel to preserve important motor information like bearing sizes and the wiring diagram for simplified servicing.

Louis Allis insulation is designed to withstand exposure to acids, alkali, or moisture to assure you of dependable service. Locked bearing construction prevents rotor drift . . . extends bearing life.

We'll gladly offer expert field application service. Contact your Louis Allis District Office or write The Louis Allis Company, 447 East Stewart Street, Milwaukee 1, Wisconsin. Ask for Bulletin 1050.

LOUIS ALLIS

MANUFACTURER OF ELECTRIC MOTORS AND ADJUSTABLE SPEED DRIVES

Melt-Out is Speeded-Up

Tankcars for melt-out operations are almost always equipped with a flat bed of longitudinal pipe coils in the bottom. Low pressure steam is admitted to the coils and then there's a long wait for natural convection to transfer the heat to the solid fat. In cold weather the melt-out period can consume several days.

There've been a few improvements in this procedure. Some processors use steam-heated buildings to increase the ambient temperature. In one case, the exterior of the car was warmed with a manually-handled jet of steam. Only one prior case of agitation is known—a standard gear-driven portable agitator was driven into the car's contents and improved the melting-out rate in the center of the tank.

TurboTube units used for this work serve two purposes:

First, by producing a high linear velocity along the steam coils, a high rate of heat transfer is obtained.

Second, by producing thorough, overall circulation of the hot oil, the melting rate of the solid is at a maximum.

On melting-out units, you sometimes have to make provision for insertion of the agitator into the hard fat or tallow. This is, of course, more of a factor in northern climes.

One method of producing a channel for the agitator is to melt out a core by direct injection of live steam. Where this injures the product, the alternative is to add a steam jacket to the draft-bend assembly.

Melt-out performance is a function of: car size, hardness of the initial material; melting point; melting behavior; ambient temperature; and, the maximum permissible steam pressure in the coils.

If the agitator is used in continuous operation in the tank car, the melt-out time for a typical lard or tallow is four hours. This is compared to 24 hours without agitation.

By cycling the agitator through a series of four cars, a total time of six hours for the four cars has been obtained. This cycling procedure uses high-pressure steam in the agitated car—the other three cars using atmospheric steam in their coils.

Using the agitator permits 100 psig. steam in the coils (338 F.) and yet oil that can't be heated above 140 F. isn't damaged. Because of the excellent velocity obtained along the coils in the bottom of the car, heat transfer from the oil to the solid fat in the top of the car controls the rate.

ROBERT L. BATES is vice-president and technical director of Chemineer, Inc.—a position he's held since 1951. He received his B.S. in Chemical Engineering in 1948 and the professional degree of Chemical Engineer last spring. Bates is a member of the A.I.Ch.E., the American Chemical Society, the American Oil Chemists Society and he's a registered professional engineer in Ohio.

There Are Limitations

Limitations of the TurboTube agitator are mainly physical ones. Handling is a problem that you must consider seriously. High weight of the unit demands a hoist. You need clearance so you can lift the unit out of the car. This means that the boom or monorail for lifting must be about 28 ft. above the track.

Submerged bearings can also be a source of trouble if certain types of abrasives are present. However, just as advancements have been made with vertical pumps, recent developments in bushing material and design have alleviated most of these difficulties.

Some New Agitators

There are a few new contenders for agitation honors. Related to the standard outboard motor is the submerged transmission agitator. It uses a motor directly coupled to a 1:1 bevel-gear transmission that drives two propellers. Since the shafts rotate in opposite directions, both propellers turn in a lefthand style.

In theory, the design is ideal. Flow is directed horizontally without resorting to the involved construction of the TurboTube agitator. But, the obvious disadvantage of a submerged shaft-seal rules it out for most services. In corrosive media, the seals must be absolutely perfect and dependable to prevent destruction of the bearings and gearing. Also the possibility of outward leakage of lubricating oil prohibits its use in fluids that can't be contaminated.

Newest entrant in the field is the immersible motor agitator. Because it hasn't been used for tankcar agitation yet, you have to consider it only in light of what you think its potential is.

Its construction is leak-tight and the casing is completely filled with oil. A single face-type mechanical seal is used for the output shaft and a diaphragm breather equalizes internal and external pressure on the unit.

Obvious limitations of this unit are ones that are imposed by the fluid regime.

As with the submerged transmission unit, the efficiency of the shaft seal is a vital factor. Although a face-type seal is considered positive, it's still difficult to cope with abrasives or hardening fluids in this mixer.

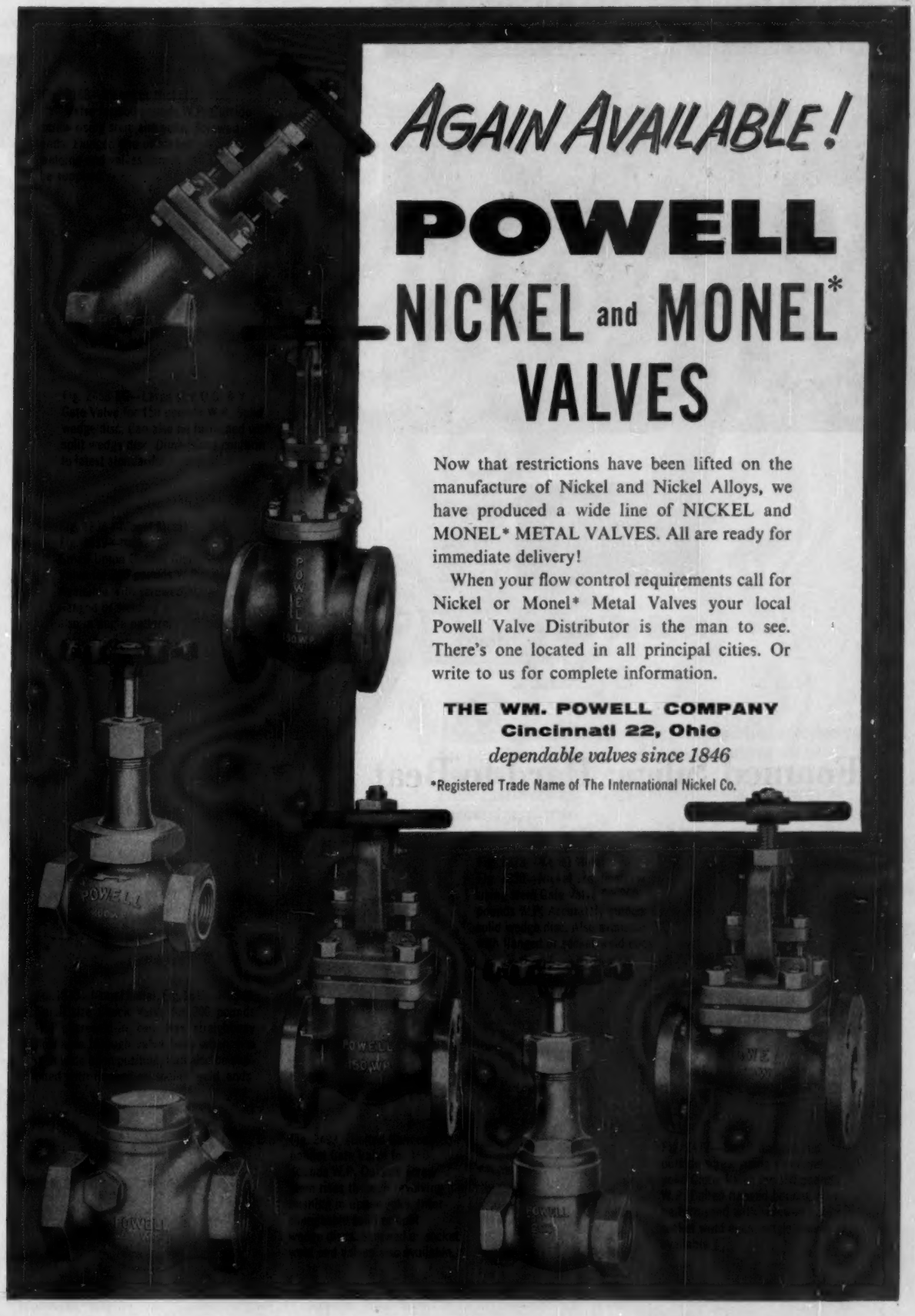
It's important to remember, these motors are designed to operate continuously when completely submerged in liquids with an ambient temperature not higher than 104 F.

While we've been pretty specific with applications for railroad tankcars, these comments are applicable to all horizontal, cylindrical tank installations. It's just that problems here aren't as severe. Those two critical restrictions—high L/T and limited mounting facility—are seldom present.

Closely allied are problems with tank trucks and trailers. With this equipment, considerations are about the same as railroad tankcars, but usually with smaller container and batch sizes.

REFERENCES

1. *Chem. Eng.*, Feb. 10, 1958, p. 80.
2. *U. S. Patent* 2,791,406.
3. Fox, E. A., and V. E. Gex, *A. I. Ch. E. Jour.*, Dec. 1956, p. 539.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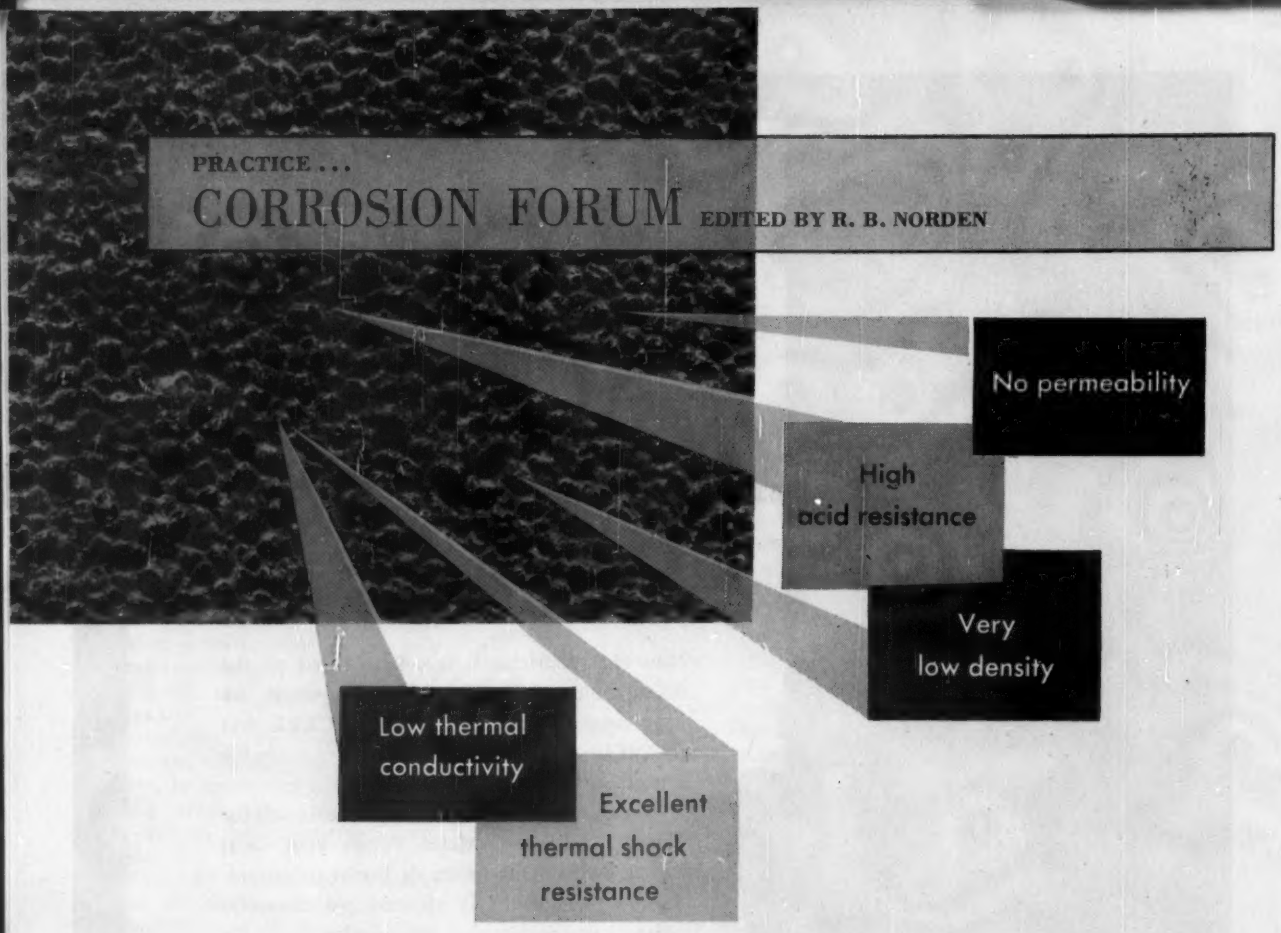


Foamed Silica: Hard-to-Beat Properties

As a chemical-resistant insulating lining, this new foamed silica has few peers. Big promising application: acidproof brick.

By foaming silica, Pittsburgh Corning engineers have come up with a novel material of construction with a unique combination of properties.

Called Foamsil,* it is 99% pure fused silica in the form of millions of noninterconnecting silica bubbles.

Two features are of particular importance to chemical engineers: it's unaffected by all acids except hydrofluoric and hot concentrated phosphoric, and it's an excellent lightweight, nonpermeable, thermal insulator.

This combination is just what you need in acidproof brick, a major market for Foamsil, according to PC (Pittsburgh, Pa.)

► **Foamed Brick**—Standard, dense acidproof brick is widely used in chemical plants, together with a membrane liner, to protect steel tanks, towers, reactors, pipe, stacks, against corrosive attack. Insulating properties are not too good, but in thick sections acidproof brick can prevent thermal damage to the membrane. The membrane is necessary because some corrosive material usually gets through the mortar (which holds the bricks together) and the brick.

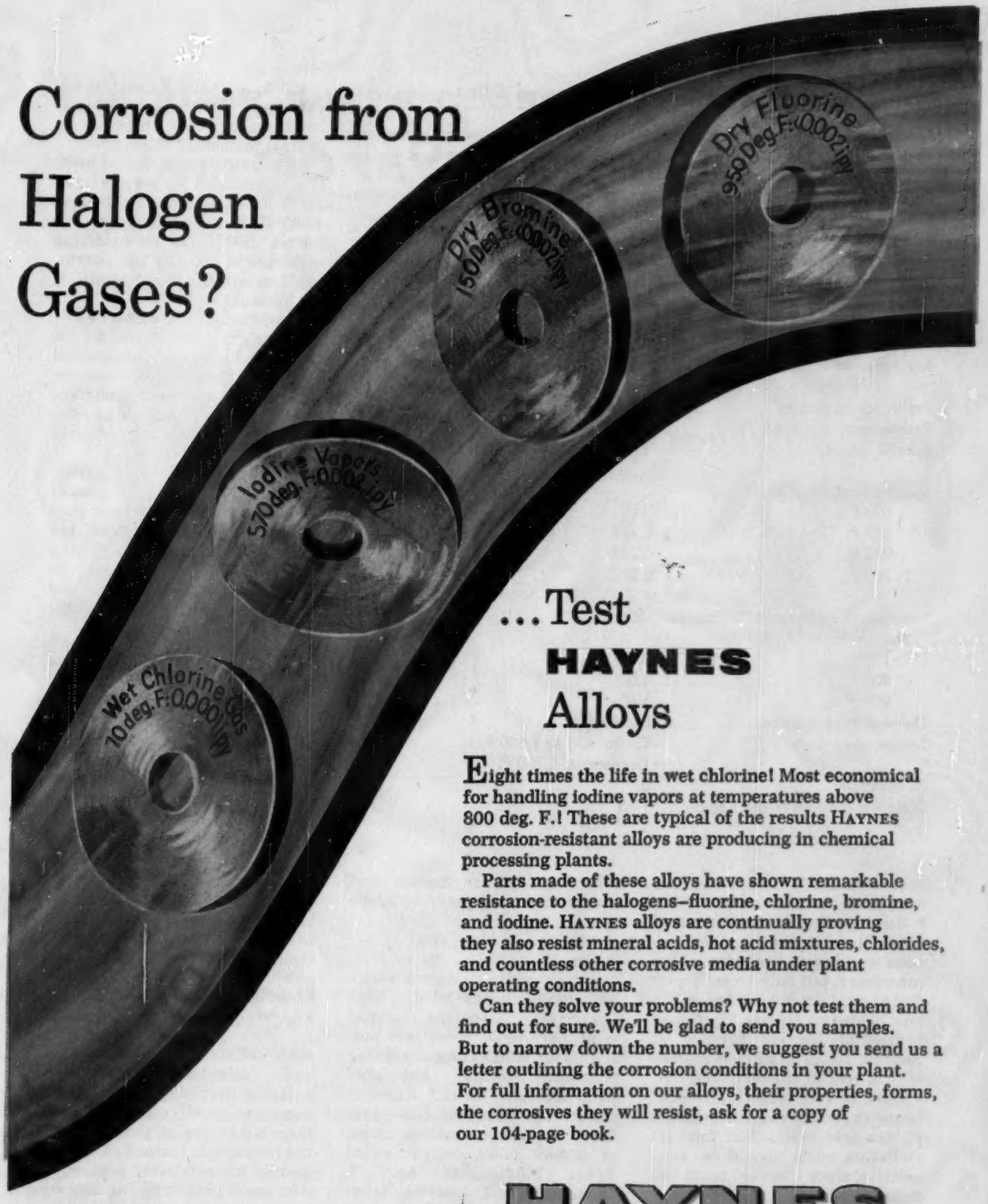
With thermal conductivities about equal to insulating fire brick, it's not difficult to see where Foamsil will fit into acid service. PC claims the insulating value of 1-in. of foamed silica is equivalent to about 18-in. of acidproof brick at 250 F., and it's 90% lighter in weight. For one thing it should greatly increase capacity of equipment where it's put in to replace conventional brick.

Chemical applications, so far, are very hush-hush. But one New Jersey chemical co. is known to be putting a 2-in. thick Foamsil brick lining inside a 64-in.-dia. lead-lined steel duct handling SO_2 gases at 1,000 F. This replaces 4-in. of acid-resisting brick plus 4-in. of Foamglas.

Another outfit is using silica foam bricks (4-in. thick) in an acid concentrator—95% H_2SO_4 at 480 F.—to protect a lead lin-

*Not to be confused with Foamglas, a brittle insulating material.

Corrosion from Halogen Gases?



...Test HAYNES Alloys

Eight times the life in wet chlorine! Most economical for handling iodine vapors at temperatures above 800 deg. F.! These are typical of the results HAYNES corrosion-resistant alloys are producing in chemical processing plants.

Parts made of these alloys have shown remarkable resistance to the halogens—fluorine, chlorine, bromine, and iodine. HAYNES alloys are continually proving they also resist mineral acids, hot acid mixtures, chlorides, and countless other corrosive media under plant operating conditions.

Can they solve your problems? Why not test them and find out for sure. We'll be glad to send you samples. But to narrow down the number, we suggest you send us a letter outlining the corrosion conditions in your plant. For full information on our alloys, their properties, forms, the corrosives they will resist, ask for a copy of our 104-page book.

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An Imposing List of Properties for Foamed Silica

Absorption	None. Any weight gained by immersion is due to wetting of cellular face.
pH	7.0
Capillarity	0
Coefficient of expansion	3.5×10^{-7}/F.
Combustibility	Incombustible
Compressive strength	130 to 210 lb./sq. in.
Density	10 to 12 lb./cu. ft.
Flexural strength	120 to 150 lb./sq. in.
Hygroscopicity	No increase in weight
Modulus of elasticity	200,000 lb./sq. in. (approximately)
Resistance to acids	Resistant to all acids except hydrofluoric and hot phosphoric.
Resistance to caustics	Should be protected.
Resistance to abrasion	Should be protected.
Specific gravity	0.16 to 0.19
Specific heat, Btu./(lb.)(F.)	
100 F	0.18
500 F	0.235
900 F	0.265
1,200 F	0.277
Thermal conductivity for 11 lb. den., Btu./sq. ft./hr./F./in.	
100 F	0.48
500 F	1.0
900 F	1.85
Thermal shock resistance	Excellent
Temperature limits	Cyclic: 450 to 1,600 F. Continuous: 2,200 F.
Permeability	0
Dielectric constant relative to air	1.35

ing. Previously this called for acid brick 23-in. thick.

▶**Hard Work**—Actually, foamed silica is not a new idea. PC has been working on the material for nine years, but only recently perfected production techniques. It's now made in a special, 70-ft.-long horizontal electric furnace at Sedalia, Mo. The silica is foamed with a special chemical additive.

Cost is relatively high—50¢/board ft., compared to 17¢/board ft. for acid brick. But final installation costs should be competitive, since you need much less foamed silica.

The acidproof brick field gets a little complicated because you also have to consider carbon and graphite. Actually, while carbon and graphite bricks stand up to acids, alkalis and solvents, they are high-cost materials. Use is limited to hydrofluoric acid and strong alkalis, where Foamsil can't be used, so carbon and graphite are not really competitive.

Available in block sizes 11x17-in. or 17 x 22-in., up to 3-in. thick, Foamsil can be cut easily into brick shapes with a masonary saw. Since the material is nonpermeable, there is a possibility of eliminating the lining membrane usually associated with acidproof brick. However the cements now available—powdered Foamsil in a setting agent, or a new silica cement called Synar (*Chem. Eng.*, Apr. 21, 1958, p. 56)—are permeable at higher temperatures, calling for a membrane lining to be absolutely safe. Pittsburgh Corning is working on improved cements which will eliminate the need for most linings.

▶**Temperature Advantages**—The new silica foam withstands thermal shock within the range −450 to + 2,200 F.—a big advantage. Most conventional bricks crack when subjected to radical temperature changes.

In practice standard acid brick is recommended for service up to 2,300 F., carbon can be used to 4,000 F. in nonoxidizing atmospheres, 660 F. in an oxidizing atmosphere. So the top operating temperature for Foamsil is not unusual.

▶**Construction Features**—Lightweight, and with a 130 to 210 lb./sq.in. compressive strength, foamed silica can be used as a load-bearing surface to eliminate supporting and reinforcing structures needed with conventional brick.

The low coefficient of expansion (3.5×10^{-7}) is 1/18 that of carbon steel. This produces good volume stability: it does not warp, slump or shrink during rapid temperature changes. So the need for expansion joints and vertical clearances are reduced; joint separations for expansion and contraction are not required.

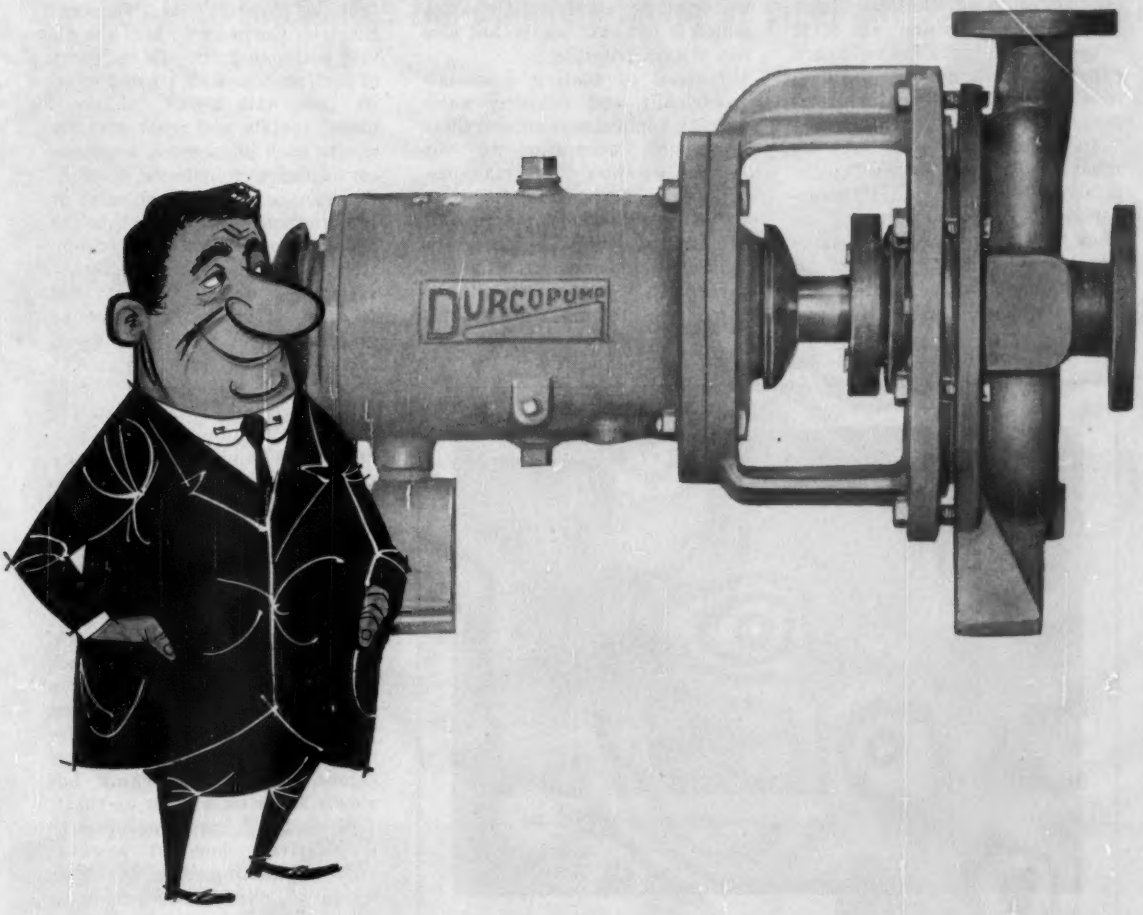
▶**Improvements Needed**—One area for improvement is very evident from a look at the table of properties. Foamsil cannot be used in any application where there is abrasion. This is a definite disadvantage, since acidproof brick stands up very well to abrasive action. PC offers limited quantities of foamed silica coated with a hard, vitreous layer for abrasive service.

Also, some of the acidproof brick producers tell us Foamsil is strictly for acid service, while their bricks—even fireclay bricks—will stand up to mild alkalis.

▶**Insulating Applications?**—As a straight insulator Foamsil is far too costly to complete with standard materials such as magnesia, asbestos, diatomite, insulating firebrick, except under some unusual situations. If there's a corrosion problem with the insulation, foamed silica can justify it's relatively high cost. Also most industrial insulations have open pores and rapidly lose their insulating properties when they come in contact with fluids. Here again Foamsil should justify its high cost. For this purpose PC makes foamed silica in prefabricated curved segments, wedge-shapes and other designs. (*Continued p.* 146)

THE PUMP THAT'S CLOSEST TO MY HEART

AND MORE DEPENDABLE!



Series H Durcopumps are designed and built to give maximum service at minimum overall cost when handling severely corrosive solutions. These pumps are built with capacities from ½ to 3500 gpm, and with heads to 345′ They are available in twelve standard corrosion resisting alloys. When you are looking for a better chemical pump, look to Durco.

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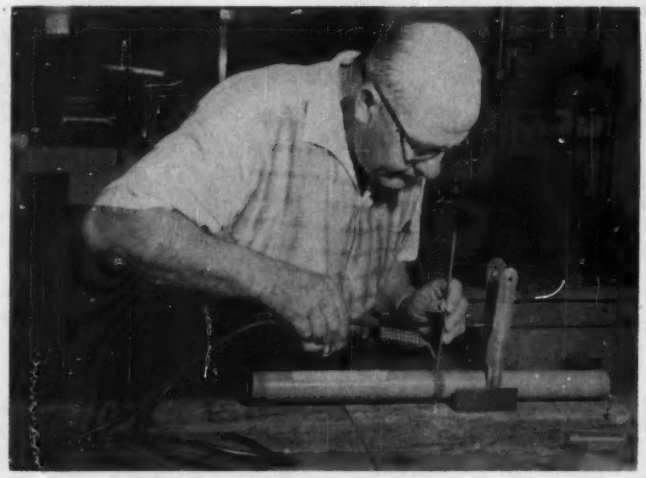
Down With Cookbook Methods

Speaking at the recent 61st annual meeting of the ASTM in Boston, Professor A. R. von Hippel, Director of the Insulation Research Laboratory at MIT, echoes some ideas we've heard expressed at a number of technical corrosion and materials of construction sessions lately.

In effect von Hippel says we must get away from the "quick-mix cake" idea in building materials of construction and go back to fundamentals. A considerable amount of research and development has been concentrated on the interaction of atoms and molecules under different conditions, but materials and corrosion engineers have very little appreciation of the physics of matter. They still attempt to meet demands for new types of materials by empirical thinking, which is not only costly, but also not always possible.

Instead of testing materials empirically and devising engineering applications around these properties, according to von Hippel, we should now make use of modern physics and chemistry for a more powerful approach. We can understand, by observing molecular phenomena, why materials fail and we can build remedies into materials against such failures. Such an approach now goes under the name of molecular engineering.

Not all materials and corrosion engineers ignore the "fundamental" approach. In fact companies such as Westinghouse, General Electric, Carpenter Steel are all very active in getting to the roots of such problems. More and more we hear talk about "tailored-made" metals, and what actually causes such phenomena as stress corrosion. For instance, Earl A. Gulbransen, advisory chemist at Westinghouse, is looking into the problem of stress corrosion. He's found that minute crystals, resembling delicate plates, tend to grow from the surface of stainless steel when the metal is stressed and exposed to a corroding atmosphere. He thinks pits or trenches form under the platelets leading to stress concentration, and a possible solution to the problem would be in controlling the formation of these crystals.



Plastic Techniques Taught at Special School

Welding plastic pipe (above) is one of the fabrication methods taught at a special school recently established by the General Tire and Rubber Co., Bolta Products Div., Lawrence, Mass. The school provides much needed information on plastic properties together with manual practice covering proper fabrication and maintenance techniques.

Set up in cooperation with the United Association of Plumbers and Steamfitters and the U. S. Dept. of Labor, the school recently graduated the first class of U.A. instructors. This group completed a five-day program (36 hr.) and will spread the good word to journeymen and master plumbers in the installing trades. Additional courses are planned.

Some of subjects covered in the course: plastic welding and machining; PVC cements; corrosion and physical property changes; threaded and victualic coupling joints; thermal expansion and contraction; allowable pressures; installation of PVC pipelines.

Infrared Lamps Stop Steel Corrosion

How do you prevent steel products from rusting when stored in a warehouse? This is a problem which has plagued metal producers for some time (steel comes in nice and shiny but slowly takes on a layer of rust).

U. S. Steel has come up with a relatively low-cost answer: Infrared heating which regulates humidity, eliminating rust-causing moisture.

In their Portland, Ore., warehouse (U. S. Steel Supply Div.), 68 infrared heaters turn on and off as the dew point of the air inside the building varies in relation to the temperature of the stored steel. When the difference between the dew point and steel temperature becomes less then a pre-set value, the entire heating circuit activates and remains on until the steel is approximately 12 F. above the dew point.

Actually 40 heaters direct their rays from a 30-degree angle at a height of 15-ft. Another 28 heaters hang in pairs from the bottom chord of the warehouse trusses which are in the center of the building. The 40 heaters have parabolic reflectors.

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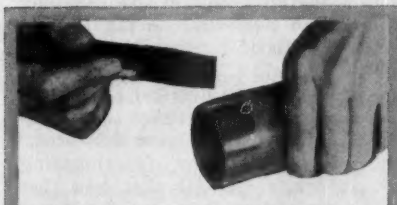
PIPE DREAMS come true!

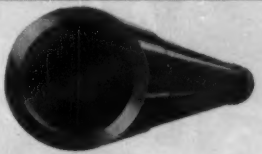
Mr. Usco introduces the complete family of pipe, valves and fittings!

USCOLITE® plastic pipe comes in two specific types, each equally good for its particular purpose. Uscolite CP for high impact resistance, Uscolite RV (PVC) for active oxidizing agents. Not one foot of pipe has had to be replaced in the 10 years since first installed.



USCOWELD* Fittings are the only solvent-weld fittings with an interference fit. Greater joint strength, faster insertion. Non-porous, leak-proof. Made of either Uscolite CP or RV materials.

USCO® VALVES offer a choice of either Hills-McCanna diaphragm valve or Vanton "Flex-Plug" gate valve.



USCOFLOW is a new, black utility pipe, especially suited where low first costs are a factor. It is a blend of styrene-base resin and synthetic rubber for good impact resistance and high tensile strength.

The "Usco" Plastic Pipe Line of precision-molded pipe and fittings for every corrosion and flow problem includes elbows, tees, couplings, flanges, reducing bushings, plugs, caps, nipples, bends.

When you think of plastic, think of your "U.S." Distributor. He's your best on-the-spot source of technical aid, quick delivery and quality plastic pipe and fittings.

*Patent applied for

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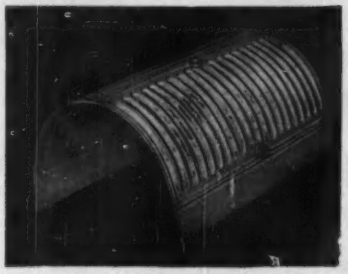
DEAN THERMO-PANEL COIL TAKES THE PLACE OF
PIPE COILS



The photo above shows a typical example of a CURVED

DEAN THERMO-PANEL COIL

It is NOT a pipe coil. It TAKES THE PLACE of pipe coils. Old-fashioned pipe coils, today, are obsolete.

The Dean Thermo-Panel Coil gives you much more heating surface per square foot than does the old-style pipe coil. It usually costs considerably less—weighs less—is more efficient—more economical—and is more quickly installed and removed for cleaning. It is superior in every way.

ALL CHEMICAL ENGINEERS who have pipe coil or similar problems should have one or both of the bulletins below. Check the square or squares, clip out and mail with your name, firm name, and address.

☐ *Bulletin 355. 52 pages. Technical Data.*
☐ *Bulletin 258. Design and Price Information.*

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FIRMS IN THE NEWS

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NEW FACILITIES

New Materials Testing Reactor Goes Critical

Westinghouse's materials testing reactor (WTR) recently went critical at Waltz Mill, Pa., site of company's reactor evaluation test center. Reactor will generate 20,000 kw., is moderated and cooled by water. Cylindrical foundation at left will support main reactor building; at right are fuel handling canals and storage areas.

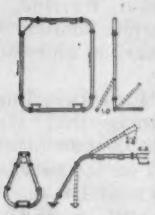
Pacific Supply Cooperative is continuing with plans for an oil refinery at Vancouver, Wash., following action by the City Council excluding firm's 114-acre site from annexation to the city. Fluor Corp. is preparing plans for refinery and will supervise construction.

Koppers is pushing plastics plans for South America: Koppers and Chemische Werke Heuls, Germany, will jointly build a low-pressure polyethylene plant in Cubato, Brazil. It will start up in 1960 with capacity of 3,600 tons/yr. And Koppers' partially owned subsidiary, Industrias Plasticas Argentinas, S.A., has signed a contract with Argentina's state-owned oil company which may ultimately result in new ethylene and polyethylene plants just south of Buenos Aires.

Monsanto Chemical Co. and Emery Industries are co-owners of a new 3,000-ton/mo. unit for fractionating crude tall oil that has just gone on stream at Nitro, W. Va. Byproduct from St. Regis Paper Co.'s sulfate pulp mills in Florida is barged to the W. Virginia unit where it is fractionated into tall fatty acids for Emery and refined tall oil rosin for Monsanto.

United Heckathorn has its new fluorine chemicals plant on stream at Garfield, Utah. At least 50% of plant's 3,000-ton/yr. capacity will go into synthetic cryolite—made by a new undisclosed process. Other chemicals include: alu-

Examples of a few typical circuit plans.



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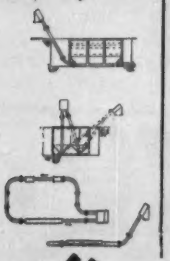
Patented SEALED-PIN CHAIN DESIGN keeps abrasives out—quadruples chain life.

Hapman TUBULAR CONVEYORS



Move almost any flowable material—wet or dry—through any plane or angle . . .

Make *big savings!* Move bulk materials *automatically*—up, down, through walls, around corners and obstacles with a Hapman! Circuits like these or complex layouts engineered to *your* needs. Usually a *single* drive unit serves where other conveyors need several. Design cuts costs. Dust and liquid *tight!*

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REDUCE OPERATING COST of VACUUM SYSTEMS with this "AERO" (air-cooled) VAPOR CONDENSER

With free air the cooling medium you use the least water, evaporated in the air stream. You save the cost and pumping of large volumes of condensing water.

Air-vapor subcooling reduces mixture evacuated from the system, saving in the operation of steam ejector or vacuum pump.

This *air-cooled* condenser gives you more capacity than other types at a substantial saving of steam and power. Water supply, scaling treatment and disposal problems are eliminated.

You get pure condensate, an improved product; often make a profit on recovery of residues now wasted. There can be no contamination of your product at any time; it never touches raw water. Condensing, of water, of solvents or of your product, is simplified; you have one, compact, easily maintained unit replacing both cooling tower and barometric or surface type condenser.

Niagara Aero Vapor Condenser. This compact machine may be installed directly above stripping column or vacuum evaporator.

Maintenance expense is low. Balanced Wet Bulb Control provide precise, year 'round adjustment of capacity to load.

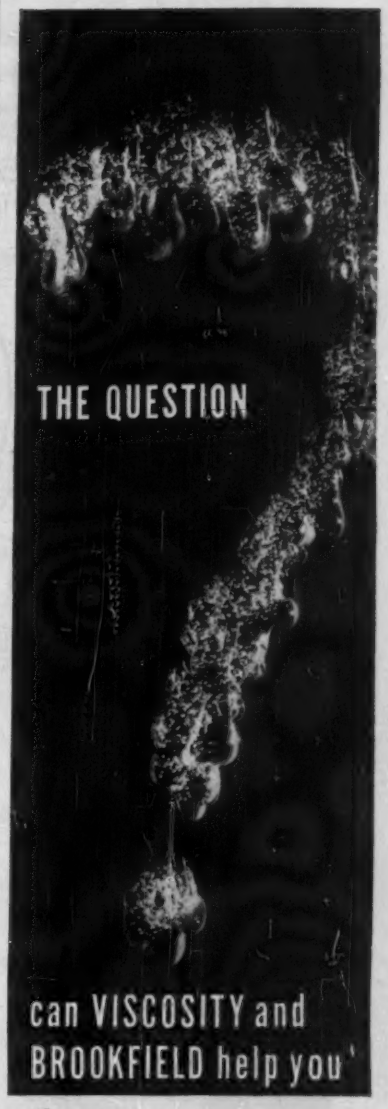
Constant temperature, uniform products and maximum production 12 months a year are assured. Unit capacities up to 15 million BTU.

Write for full information. Ask for Bulletin 129R

NIAGARA BLOWER COMPANY

Dept. CE-8, 405 Lexington Ave., New York 17, N.Y.

Niagara District Engineers in Principal Cities of U. S. and Canada



the answer — in dollar signs — is YES, if fluid behavior is important in your process or to your product. Viscosity can represent a fundamental property which will determine a fluid's ultimate composition or quality in use — it can be measured, evaluated, and effectively controlled with Brookfield Synchro-Lectric Viscometers or process-mounted Viscometrans.

Today, many of the CPI's most profitable processes are depending on viscosity measurement — the most fundamental gauge of reaction progress. The broad line of Brookfield instruments and accessories make this control possible at low investment.

Complete information is yours by return mail. We welcome you to write, wire or call today.

the world's standard for viscosity measurement and control

Brookfield

ENGINEERING LABORATORIES INCORPORATED

STOUGHTON 13, MASSACHUSETTS

Life in these excited states...

High-impact, rubber-plastic, most economical for average chemicals. ½ to 6". Screw or solvent welded fittings. Valves ½ to 2". NSF-approved. *Bul. 80A.*

An easier way to put corrosion under your thumb

Specify the equipment that's engineered to stay on the job under the toughest corrosive service . . . *Ace* equipment by American Hard Rubber Company. Now nine kinds of plastic and rubber pipe, plus pumps, valves, tanks, and special equipment to solve any corrosion or contamination problem.

Rubber or plastic lining is economical life insurance for costly "special" equipment. It's a specialty with ACE. Write for *Bul. CE-53.*

Choice of Riviclor PVC, Ace-Ite rubber-plastic, Ace polyethylene or Ace Saran to match *any* plastic pipe. Sizes ½ to 2". Also larger plastic-lined valves.

Ace-Hide, tough as a rhinoceros, insensitive to corrosives, makes this finest of acid pails. Also dippers, bottles, funnels, etc.

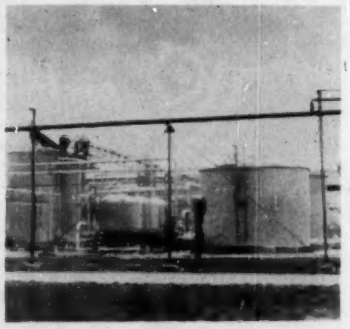
See our pages in eee Catalog!

ACE processing equipment of rubber and plastics

AMERICAN HARD RUBBER COMPANY
DIVISION OF AMERACE CORPORATION
Ace Road • Butler, New Jersey

minum fluoride, ammonium fluoride, sodium fluoride and potassium aluminum fluoride.

Estes Park Beryllium Corp. announces that it's going to erect a new ore processing mill on its beryl ore properties near Drake, Colo. Capacity will be around 200 tons raw material daily.



Pennsalt Chemicals Corp.'s Mexican subsidiary, Industrial Quimica Pennsalt, S.A., has swung a new 35-ton/day caustic-chlorine plant (above) on stream at Santa Clara, a suburb of Mexico City. Pennsalt of Canada has also opened a new plant: A chemical specialties facility in Oakville, Ont.

Chemetron's National Cylinder Gas Div. has broken ground for an industrial gas producing plant in Erie, Pa. Capacity at startup (around Jan. 1) will be 7.5 million cu. ft./mo.; unit will pipe continuous supply of oxygen to Erie Forge & Steel Co.

Ohio Fuel Gas Co. recently received a Federal Power Comm. go-ahead for converting company's depleted gas field in Medina County, Ohio, into an underground natural gas storage area. Initial expenditure of $2 million will bring ultimate storage capacity to 8.5 billion cu. ft.

Du Pont has opened a new high-purity silicon plant at Brevard, N. C. With annual payroll of $1.5 million, plant was described by company spokesman as "first full-scale plant" for production of high-purity

silicon—widely used in electronics applications.

Waverly Chemical Co. is scheduling a $400,000 construction project on a newly acquired site near Phillipstown, N. Y. New facilities, slated to be in operation by late spring of 1959, will produce a comprehensive line of surface active agents.

Carborundum's board of directors has earmarked $6 million for new grinding wheel plant at Niagara Falls, N. Y. New facility will feature specially designed automatic and semi-automatic machinery for improved production control.

Armour & Co.'s Chemical Div. is putting a new ethoxylation plant on stream at McCook, Ill. Armour's etho-chemicals find use as emulsifiers, detergents, wetting agents, dispersants and suspending agents.

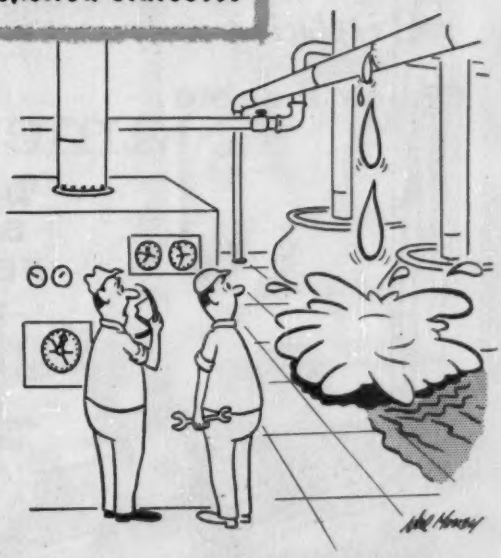
MERGERS & ACQUISITIONS

Magnolia Petroleum Co. will pay out $100 million for Freeport Sulphur Co.'s interest in the Lake Washington oil and gas field in Plaquemines Parish, La. Properties purchased by Magnolia consist of interests ranging from 10% to 50% in 90 oil wells and 6 gas wells.

Houdaille Industries, Buffalo, N. Y., has acquired a large Canadian engineering and manufacturing firm, Provincial Engineering, Ltd., Niagara Falls, Ont. "An investment in excess of $2 million" is involved.

Guardian Chemical Corp., Long Island City, N. Y., has purchased controlling interest in Shield Chemical Ltd., Toronto, Ont. Shield will manufacture and distribute Guardian's pharmaceutical and chemical products in Canada.

Life in these excited states...



"I can't stand that constant drip-drip-drip!"

Corrosion got the drop on you?

Little drips can mean big losses... repairs, downtime, ruined equipment. You can put an end to 85 to 100% of these problems with Ace chemical-resistant rubber and plastic piping, valves, pumps, tanks and other equipment. American Hard Rubber Company's 108 years of experience is at your service.

All-purpose rigid PVC. Sched. 40, 80 & 120, ½ to 4". Threaded or socket-weld fittings. Valves ½ to 2". NSF-approved. *Bul. CE-56.*

Improved design . . . now 12 gpm. All wetted parts acid-resistant, wear-resistant Ace hard rubber. Finest available. *Bul. CE-55.*

Flexible poly pipe, ideal for water lines, drains, underground pipe or conduit. Sizes ½ to 2", long coils, NSF-approved for drinking water. *Bul. CE-57*

World's best chemical valves . . . at moderate prices. All-plastic, rubber-lined, or all-hard-rubber. ⅛" pet cocks to 24" gate valves.

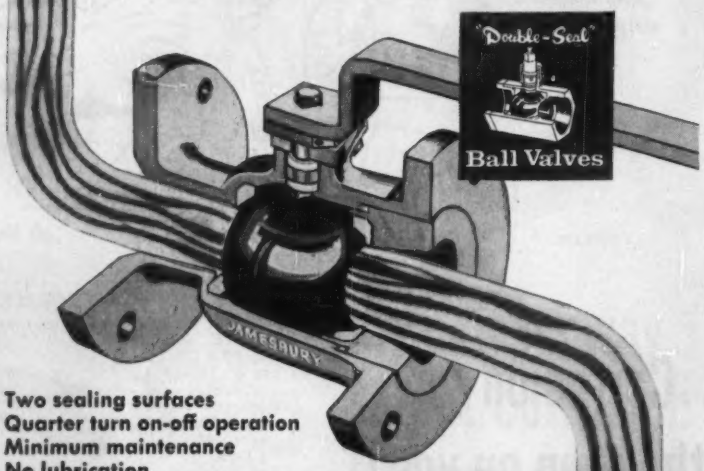
ACE processing equipment of rubber and plastics

AMERICAN HARD RUBBER COMPANY
DIVISION OF AMERACE CORPORATION
Ace Road • Butler, New Jersey

HOW TO KNOW WHOSE VALVE YOU NEED...

for ■ *specifying on new equipment*
replacing on present installations

Check these ● Jamesbury "Double-Seal" Ball Valve FEATURES



- Two sealing surfaces
- Quarter turn on-off operation
- Minimum maintenance
- No lubrication
- Highest chemical and corrosion resistance
- Handles widest range of liquids and gases
- Replaceable and interchangeable seats and seals
- Standard design and dimensions
- Built-in abrasion resistance– extra long service life
- Wide selection of materials — Bronze, Aluminum, Stainless and Carbon Steels — Polyvinyl Chloride
- Size range depth– Pipe sizes ¼" to 8"
  Tubing sizes ¼" to 1½" (High pressure)
- Choice of styles — Screwed end ¼" to 2"
  Flanged end ½" to 8"
- Easily adapted for remote control devices
- Design permits repacking while valve remains on line
- High-flow capacity with minimum friction loss
- Positive shut-off — no leakage, from vacuum to full rated pressure. Low torque
- Self-compensating for temperature and pressure
- Readily available from local distributor stock

Jamesbury "Double-Seal" ™ Ball Valves are ideal wherever zero leakage is an important requirement. The absence of metal-to-metal contact of working parts eliminates galling and corrosion, thus assuring extensive and reliable service.

Double-Check jamesbury Features:

- ☐ Send for descriptive "At Your Service" booklet.
- ☐ Write for complete catalog under your company letterhead.
- ☐ Inquire about local Jamesbury Stocking Distributors.

224-B

JAMESBURY CORP., 55 NEW STREET, WORCESTER, MASS.

CALENDAR

Cryogenic Engineering Conference, Massachusetts Institute of Technology.
Sept. 3-5 Cambridge, Mass.

American Society of Mechanical Engineers, International Conference on Air Pollution, Hotel Statler.
Sept. 4-5 New York, N. Y.

Federation of Belgian Chemical Industries, 31st International Congress of Industrial Chemistry.
Sept. 7-20 Liege, Belgium

American Chemical Society, 10th national chemical exposition, International Amphitheatre.
Sept. 9-12 Chicago, Ill.

Technical Assn. of the Pulp and Paper Industry, 3rd International Mechanical Pulping Conference, Chateau Frontenac.
Sept. 10-12 Quebec, Que.

Society of Plastics Engineers, technical conference: Plastics in Automotive Application, St. Clair Inn.
Sept. 12-13 St. Clair, Mich.

Instrument Society of America, 13th annual Instrument-Automation Conference, Convention Hall.
Sept. 15-19 Philadelphia, Pa.

Canadian Agricultural Chemicals Assn., 6th annual meeting and conference, Fort Garry Hotel.
Sept. 15-17 Winnepeg, Manitoba

Technical Assn. of the Pulp and Paper Industry, 3rd International Fundamental Research Symposium, Queen Elizabeth Hotel.
Sept. 15-17 Montreal, P. Q.

American Institute of Chemical Engineers, national meeting.
Sept. 21-24 Salt Lake City, Utah

Technical Assn. of the Pulp and Paper Industry, 12th Alkaline Pulping Conference, Arlington Hotel.
Sept. 24-26 Hot Springs, Ark.

Chemical Market Research Assn., market research conference, French-Lick-Sheraton Hotel.
Sept. 24-26 French Lick, Indiana

Electrochemical Society, Chateau Lauer.
Sept. 28-Oct. 21 Ottawa, Ont.

Technical Assn. of the Pulp and Paper Industry, 9th Paper Testing Conference, Oglethorpe Hotel.
Sept. 30-Oct. 3 Savannah, Ga.

Oak Ridge National Laboratory, Conference: Analytical Chemistry in Nuclear Reactor Technology.
Sept. 29-Oct. 1 Gatlinburg, Tenn.

Society of Plastics Engineers, New England Section, regional technical conference, Statler-Hilton Hotel.
Oct. 1 Hartford, Conn.

American Institute of Chemical Engineers, New York Section, all-day symposium: Cost Engineering, Trade Secrets & Patents, Petrochemicals, Fermentation, Hotel Statler.
Oct. 23 New York, N. Y.

MUELLER BRASS CO. **PVC** (POLYVINYL CHLORIDE)

RIGID PLASTIC PIPE AND FITTINGS

for dependable, low cost chemical handling and industrial piping

CORROSION RESISTANT PVC pipe and fittings are immune to the corrosive action of most acids, alkalies, liquids and gases. The smooth interior walls minimize the build-up of deposits, assuring unrestricted flow.

DURABLE AND DIMENSIONALLY STABLE PVC has high tensile strength and the durability to withstand heavy shock loads, vibrations and rough handling. Dimensional stability is excellent under stress, impact and moderately high temperature.

ECONOMICAL MUELLER BRASS CO. PVC products provide a low-cost solution to corrosion problems . . . lightweight for fast, easy handling . . . rugged, long wearing, no need for frequent replacement . . . Either threaded or solvent cemented piping systems can be readily installed.

Write today for your free samples

NORMAL IMPACT PVC — good impact strength . . . maximum chemical resistance.
HIGH IMPACT PVC — maximum impact strength . . . high chemical resistance.

Pipe is fabricated in 20' lengths; ½" through 3" sizes — I.P.S. schedules 40 and 80. Fittings are available in ½" through 3" sizes; threaded and socket-type for schedule 80 and in socket-type only for schedule 40.

MUELLER BRASS CO. PORT HURON 51, MICH.

Polyethylene pipe and plastic fittings, copper tube, valves and fittings

3 NEW METHODS OF BULK HANDLING

SUPERIOR AIR CONVEYING REALLY CUTS COSTS

1. Air unload powder or granular material efficiently with the new Superior "CYCLO-VAC".
2. Convey material anywhere through sanitary pipelines with a Superior "FLUIDIZER".
3. Switch lines instantly, "on stream" with the new Superior flow diverter.

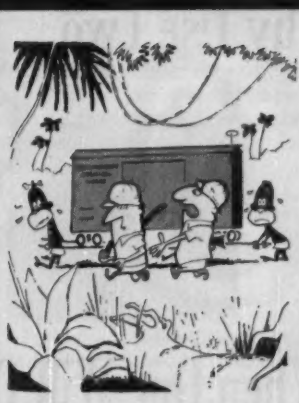
Superior . . . most advanced in modern air handling

PROCESS MACHINERY DIVISION

Product Sales or Systems Engineering

Superior

SUPERIOR SEPARATOR CO.
121 S. Washington, Hopkins, Minn.
WEst 8-7651



"When *Mallinckrodt* promises delivery on *Stearates* they sure mean it."

Seriously speaking . . .

Mallinckrodt Stearates have an important function in the plastics industry. **Zinc stearate** and **calcium stearate** are used as internal and external lubricants.

Aside from the plastics industry, **zinc stedrate** is one of the best flatting agents in lacquers. **Aluminum stearates** have gelling characteristics which are important in the manufacture of greases and paints, and in underground treatment of oil wells.

Because of Mallinckrodt's experience, facilities and reputation for producing pure dependable products, many industries come to Mallinckrodt as their source for process chemicals.

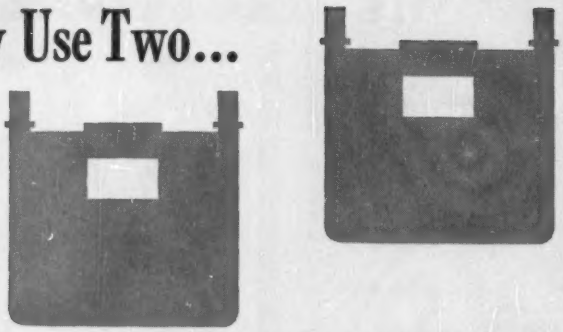
Remember . . . you might be better served by Mallinckrodt

SEND FOR OUR INDUSTRIAL CHEMICALS PRICE LIST

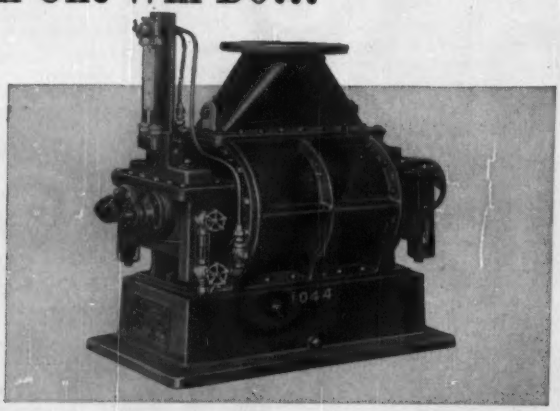
Mallinckrodt®

MALLINCKRODT CHEMICAL WORKS
ST LOUIS • NEW YORK • MONTREAL

Why Use Two...



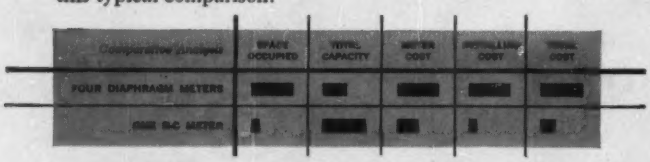
When One Will Do...



Better!

When *one* Roots-Connersville rotary gas meter is used in place of *two* . . . or *three* . . . or *four* of other types, metering costs go down.

This fact has been proved by utility companies and commercial and industrial users of gas everywhere as shown in this typical comparison:



First cost is substantially reduced with the proper selection of the *one* Roots-Connersville meter, from the 39 sizes offered, for a specific requirement. Further savings are made in foundation, piping and installing costs, and in space.

But this is only part of the story. Roots-Connersville gas meters assure unalterable accuracy with far less maintenance than required by other types. There are no valves, valve gear or other small parts to wear out and cause inaccuracies. Servicing is limited to lubrication of bearings and gears and an occasional check of the operating differential.

For additional data, please refer to our section in **Chemical Engineering Catalog** or **Mechanical Catalog** or write for descriptive Bulletin M-152.

ROOTS-CONNERSVILLE BLOWER

A DIVISION OF DRESSER INDUSTRIES, INC.

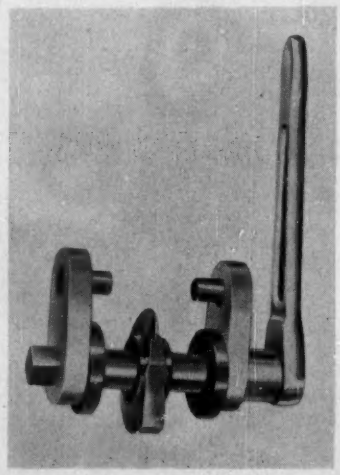
858 Illinois Ave., Connersville, Indiana. In Canada—629 Adelaide St., W., Toronto, Ont.

NEW EQUIPMENT . . .

(*Continued from p.* 80)

ness and low maintenance cost which are essential to the processes.

Packaged plants, either fully or partially engineered by the manufacturer, come in capacities ranging from ¾ to 8 tons/day.—**The Pfaudler Co., Rochester, N. Y.** **80D**



Flange Spreader

Lightweight tool spreads flanges safely.

After flange bolts are removed, anchor the new Safety Boy tool by placement of its two pins into flange bolt-holes. Insert the tapered edge of the circular cam wedge between the flanges and apply pressure to the ratchet handle—the flange is open.

According to the manufacturer, this new pipefitter's tool will safely spread a flange in a matter of seconds. Heat-treated steel construction.—**Wm. L. Riggs Co., Tulsa, Okla.** **154A**

Bin Vibrators

Feature quiet but efficient pin-point action.

Concentrated vibratory action of a new series of "pin-point" vibrators assures continuous, smooth materials flow within bins, hoppers and chutes. The units are designed for application at the precise point of diffi-

culty—wherever materials tend to pack, bridge or stick.

Working directly from a 50- or 60-cycle a.c. line, the vibrators are also characterized by almost noiseless operation; nothing more than a muffled purring sound comes through the dust-proof housing. Although the new units don't require control boxes, the manufacturer points out that accessory controls do result in greater efficiency and flexibility by enabling change of vibration amplitude to handle widely varying loads. Three models are available.—**Eriez Mfg. Co., Erie, Pa.** **154B**

Foamed Silica

New material has many desirable characteristics.

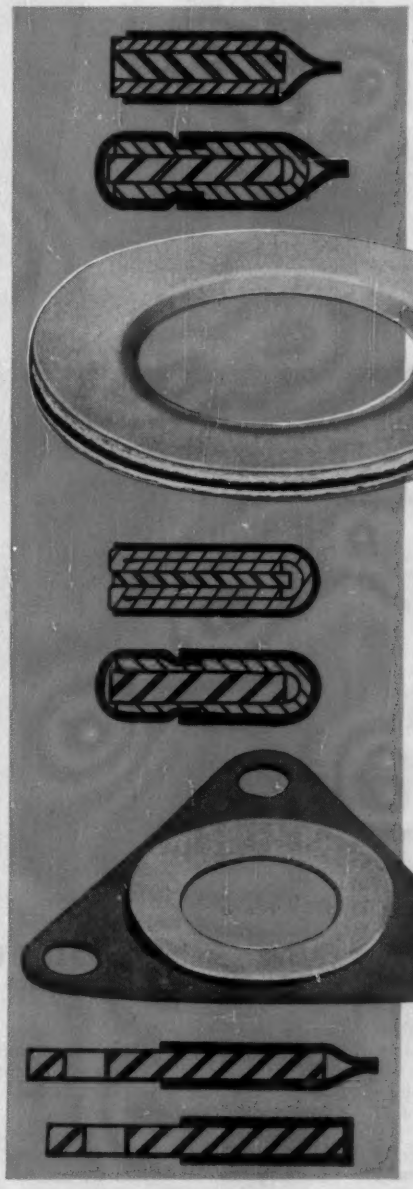
Now available in large quantities, an acid-resistant insulating and refractory substance known as Foamsil promises to be a useful addition to industry's materials of construction list. Consisting of 99% pure fused silica having a closed cell structure, Foamsil is unaffected by all acids except hydrofluoric and hot phosphoric, yet weighs only 10% as much as conventional acid brick. It withstands thermal shock within the range of −450 F. to 2,200 F., and is completely impervious to liquids and gases. Compressive and flexural strengths run upwards of 120 psi.; thermal conductivity is comparable to average-quality insulating firebrick.

Available in block sizes of 11 x 17 and 17 x 22 in., and thicknesses to 3 in., Foamsil also comes as cylindrical and curved segments. For further

Chemiseal® Gaskets

. . . with protecting Jackets of du Pont TEFLON, are impervious to all known chemicals*. They are made with a variety of filler constructions to suit every connection problem—every pipe and nozzle material requirement—whether glass, ceramics, stainless, Karbate, Haveg, glass-lined steel, etc. That is why Garlock 8764 Chemiseal Gaskets have become the standard choice of the process industries.

*Excepting molten alkali metals, fluorine at elevated temperatures and complex halogen compounds.



Illustrated at left is the standard Chemiseal slit-envelope Ring type Gasket designed to fit inside the bolt circle of flanges drilled to 125 lb. standards and made for all standard pipe sizes up to 10" I.D. Stocked for all Pfaudler and Glascote standard nozzle sizes from 1½" to 10" I.D.

Also available as shown with double jacket protecting O.D. as well as I.D. against corrosion.

Illustrated at left is Chemiseal formed-shield Ring type Gasket for large diameter glass-lined steel or special material nozzles and irregular shaped openings. Also available as shown with double formed-shield protecting both O.D. and I.D.

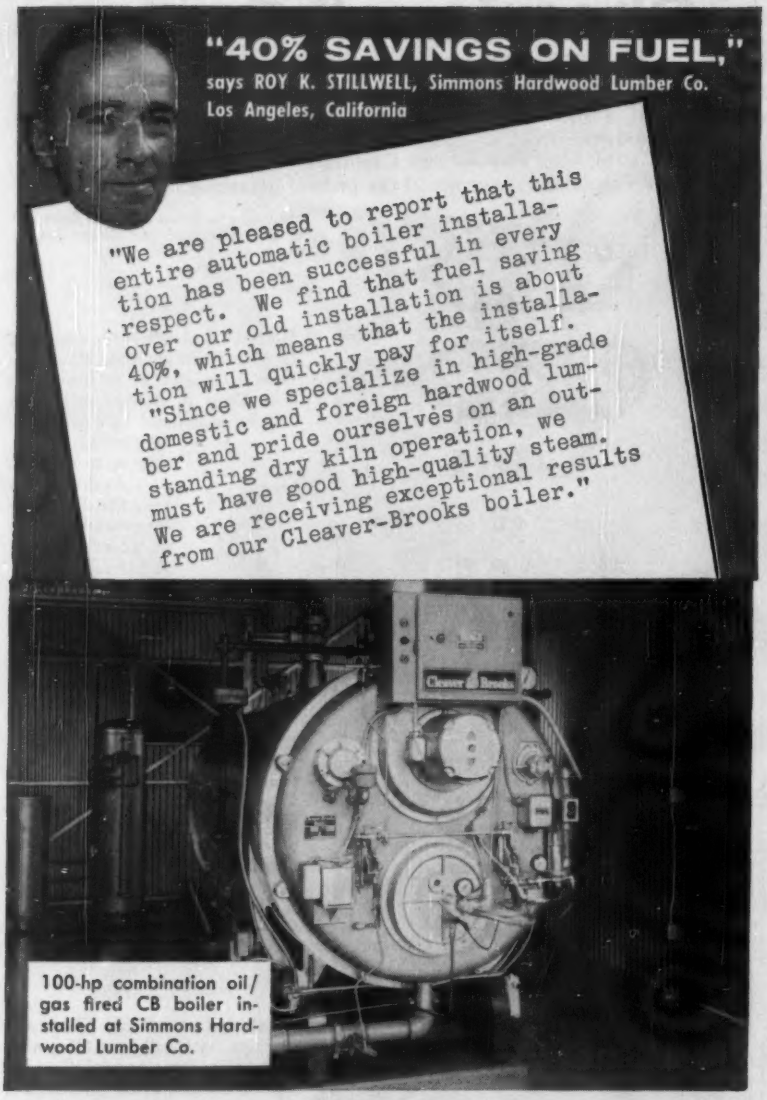
Illustrated at left are Chemiseal Gaskets with full face filler with bolt holes, for standard Corning conical flanges. These gaskets seal with unusually low bolt loads. Shown are both slit-envelope and milled-envelope types.

Milled-envelope type fits flush with the pipe I.D. and provides minimum impedance to flow. This type Jacket is supplied either with full face filler or with filler to fit inside bolt circle on standard 125 lb. flanges.

For prompt service, contact one of The Garlock Packing Company's 30 sales offices and warehouses throughout the U.S. and Canada, or write for Bulletin AD-154.

United States Gasket Company
Camden 1, New Jersey

United States Gasket *Plastics Division of* **GARLOCK**


"40% SAVINGS ON FUEL,"
says ROY K. STILLWELL, Simmons Hardwood Lumber Co.
Los Angeles, California
"We are pleased to report that this entire automatic boiler installation has been successful in every respect. We find that fuel saving over our old installation is about 40%, which means that the installation will quickly pay for itself.
"Since we specialize in high-grade domestic and foreign hardwood lumber and pride ourselves on an outstanding dry kiln operation, we must have good high-quality steam. We are receiving exceptional results from our Cleaver-Brooks boiler."
100-hp combination oil/gas fired CB boiler installed at Simmons Hardwood Lumber Co.

For process steam economy . . .

Install a packaged CB boiler

CB boiler four-pass design with forced draft is the most efficient combination to transmit heat to boiler water. Forced draft blower provides correct amount of air for complete combustion, eliminates the need or cost of a high, expensive chimney. Combustion gases are forced at high velocity through the four passes, literally scrubbing heat from the flame. Result: lower fuel costs.

Five square feet of heating surface per boiler hp is another reason why CB boilers give you longer service life with less maintenance. Every CB boiler is guaranteed to operate at a minimum efficiency of 80%.

Each Cleaver-Brooks self-contained boiler is a complete package. Fully factory tested, it's ready for installation, service connections and operation. No make-ready delays . . . no extra parts needed.

A trained technician starts your CB boiler, adjusts it for your specific needs, and trains your attendant in care and maintenance.

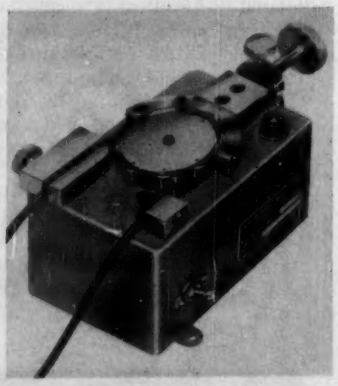
Available in 19 sizes, 130 models, 15 to 600 hp — steam or hot water, gas, oil, or combination oil/gas fired.

For more facts on the self-contained CB boiler, contact your dealer or write: Cleaver-Brooks Company, Dept. J, 345 E. Keefe Ave., Milwaukee 12, Wisconsin.

Cleaver Brooks®

ORIGINATORS OF SELF-CONTAINED BOILERS

details, see Corrosion Forum, p. 142.—**Pittsburgh Corning Corp., Pittsburgh, Pa.** 155A



Metering Pump

For slow transfer of liquids and gases.

A newly designed series of metering pumps moves liquids and gases through rubber or plastic tubing at exceptionally low rates with predetermined accuracy. Particularly useful for injection of reactants catalysts and inhibitors into process equipment, the pumps come in two models, providing an over-all capacity range adjustable from 2 ml./day to 75 ml./min.

In operation, a small roller-covered rotor compresses tubing placed between the rotor and a metal yoke—each pair of rollers traps a portion of the pumped fluid, and moves it through the tube. Ideal for corrosive, radioactive and sterile operations. — **New Brunswick Scientific Co., P.O. Box 606, New Brunswick, N. J.** 156A

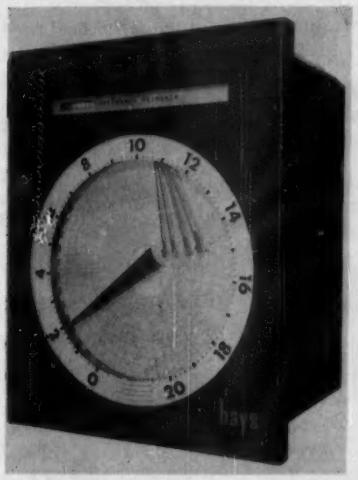
Packaged Burner

Ideal for pressurized or natural-draft boilers.

Compared with induced-draft units, the new WhirlBlast forced-draft burner system provides cleaner combustion, requires less power and operates more quietly, according to the manufacturer. A new-design burner head prevents flame pulsation and minimizes required stack height. Installation in-

volves little more than bolting to the boiler front and making necessary service connections.

Capacity ranges from 1.2-3.6 million Btu./hr. for gas, and 8-24 gal./hr. of No. 2 or lighter oil. The flip of a switch changes from one fuel to the other.—**Iron Fireman Mfg. Co., Cleveland, Ohio.** 156B



Electronic Recorder

Multi-receiver recorder designed for four inputs.

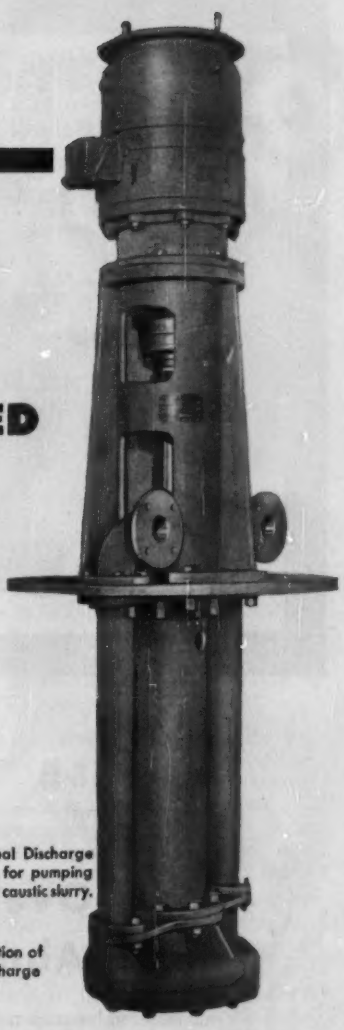
This new circular-chart instrument can record up to four linear or non-linear inputs simultaneously. Two different electronic receivers are available: differential transformer and slidewire types. Accessories for each of the receivers include retransmitting slidewires, alarm switches and retransmitting differential transformers.

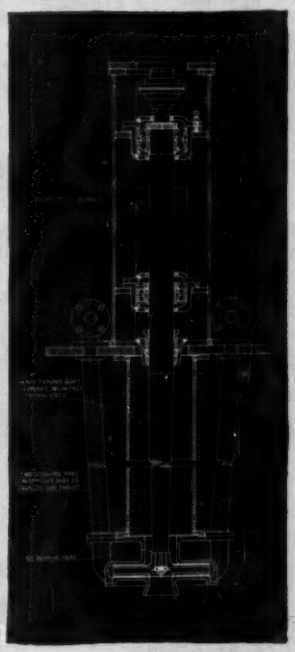
Provisions for integrators or directly actuated pressure and temperature receivers result in further instrument versatility. Amplifier handles a.c. or d.c. inputs, 10-100 mv.; 0.2-2 megohm input impedance, 0-3,000,000 gain.—**Hays Corp., Michigan City, Ind.** 157A

BRIEFS

Cycle timer unit incorporates several control circuits, each circuit for a different equipment item. All circuits have 96 self-contained tripping

VERTICAL PUMPS WITH NO SUBMERGED BEARINGS FOR PUMPING ABRASIVE CORROSIVE SLURRIES





2" Dual Discharge Pump for pumping molten caustic slurry.

Cross section of Dual Discharge Pump.

This rugged type of service calls for advanced design: — extra heavy shaft, double-ported casing to equalize the side thrust of the impeller, and tough abrasion-corrosion resistant alloys. The dual discharge pump illustrated here incorporates these features and dispenses with bearings or packing below the cover plate where they would be in contact with the liquid.

Difficult pumping problems, particularly in the process industries, have been our specialty for ninety-one years. Perhaps we can be of help to you. Write us — no obligation.

LAWRENCE PUMPS INC.

Write for Bulletin 203-7 for Complete summary of acid and chemical pump data.

371 MARKET STREET, LAWRENCE, MASS.

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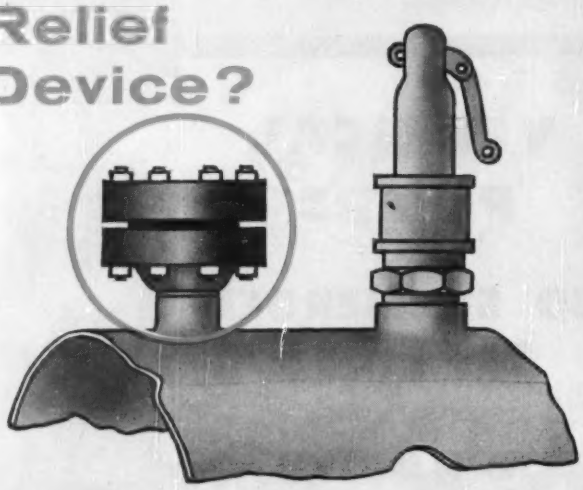

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clips. A heavy duty synchronous motor drives the entire unit.—**Zenith Electric Co., Chicago, Ill.** 157B

Rotary blowers, designed for heavy-duty service at pressures to 10 psi., deliver a precisely regulated volume dependent on operational speed. Available in 30 sizes for capacities to 30,000 cfm.—**Sutorbuilt Corp., Compton, Calif.** 158A

Spray dryer, compactly designed for water evaporation rates to 100 lb./hr., boasts great ease and speed of cleaning. All stainless steel contact surfaces protect product purity.—**Nichols Engineering & Research Corp., New York, N. Y.** 158B

Equipment Cost Indexes . . .

	March 1958	June 1958
Industry		
Avg. of all	231.2	230.7
Process Industries		
Cement mfg	222.9	222.2
Chemical	232.4	231.7
Clay products	216.6	216.0
Glass mfg	219.4	218.8
Paint mfg	223.8	223.1
Paper mfg	223.9	223.3
Petroleum ind	228.6	227.9
Rubber ind	231.4	230.7
Process ind. avg	228.8	228.2
Related Industries		
Elec. power equip	234.2	234.3
Mining, milling	233.8	233.1
Refrigerating	261.5	260.7
Steam power	219.5	218.4

Compiled quarterly by Marshall and Stevens, Inc. of Ill., Chicago, for 47 different industries. See Chem. Eng., Nov. 1947, pp. 124–6 for method of obtaining index numbers; Feb. 24, 1958, pp. 143–4 for annual averages since 1913.

For More Information . . . about any item in this department, circle its code number on the **Reader Service** postcard (p. 171)

SCRUBBING CORROSIVE GASES?

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Corrosionomics

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TANTALUM HEATERS IN HOT HCl SERVICE SINCE 1947

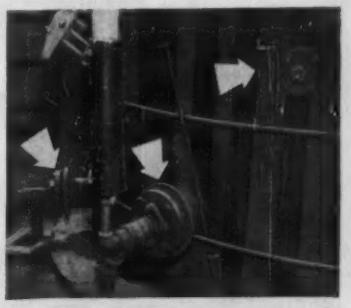
In continuous service since 1947, two Fansteel tantalum bayonet heaters have solved a major corrosion problem for the A. E. Staley Mfg. Co. at Decatur, Ill. The company produces large amounts of monosodium glutamate, an amino acid salt which enhances the flavor of food. The first step in processing is the hydrolysis of several amino acids in corn gluten with hot HCl.

Heats at 1,800,000 Btu per Hour

At the outset, approximately 15,000 lbs. of 18° to 20° Be HCl plus 100 gallons of water must be heated in one hour to 150° F. The two Fansteel tantalum bayonet heaters accomplish this in a Haveg tank, under 60 psig steam. Each measures 72" long, by 1½" in diameter. In addition, acid heating cycles are regulated by a temperature controller using a thermocouple in a tantalum thermowell.

The heat transferred ranges from 1,200,000 to 1,800,000 Btu per hour, depending upon the entering temperature of the acid from outdoor storage tanks at ambient temperature. Since the bayonet heaters have an area of about five square feet, the heat transfer coefficient attained is about 1,400 Btu per hour per degree F per square foot.

Tantalum bayonet heater in side opening of Haveg tank. Dry corn gluten is shown in hand.



Arrows indicate tantalum bayonet heaters and thermowell in Haveg tank.

No Corrosion—Even with Continuous Exposure

As can be appreciated, corrosion is a major problem in this process—and tantalum is one of the few materials of construction that has resisted corrosive attack successfully. Three tantalum heaters were installed as original equipment, but the process now operates on two with ample heating capacity. The A. E. Staley installation, along with a host of others, have proved tantalum's complete immunity to HCl at all concentrations and temperatures up to and including constant boiling temperatures. Among these are numerous instances where tantalum equipment has been subjected to hot HCl for 15 years and more with no perceptible attack.

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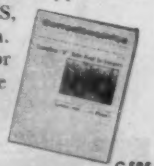
The above condensation is typical of the articles which appear in CORROSIONOMICS, a Fansteel publication. Mail us your name for inclusion on our free mailing list.



G585A

For further data on the above, write:

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CHEMICAL EQUIPMENT DIVISION
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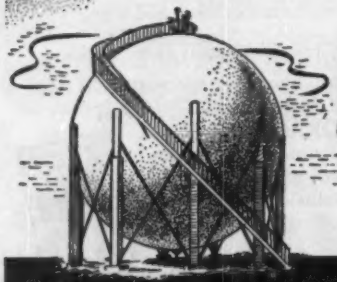

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TECHNICAL

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technical man in fields other than plastics, who is interested in how polyethylene may be of value in his business."

Roughly the last half of each book focuses on applications, with the first half providing a foundation of general properties, basic chemistry, manufacture and fabrication. Typical of the organization of the applications sections are the polyethylene book's subheadings: film, coatings, pipe, coated wire, moldings, brown bottles, vacuum formings, miscellaneous extrusion and processes, future prospects. Illustrations and data charts and tables are plentiful.

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BRIEFLY NOTED

AIR CONDITIONING — Catalog of Technical Reports (CTR-342). *Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C.* 25¢. Lists available research reports from 1931 to 1958.

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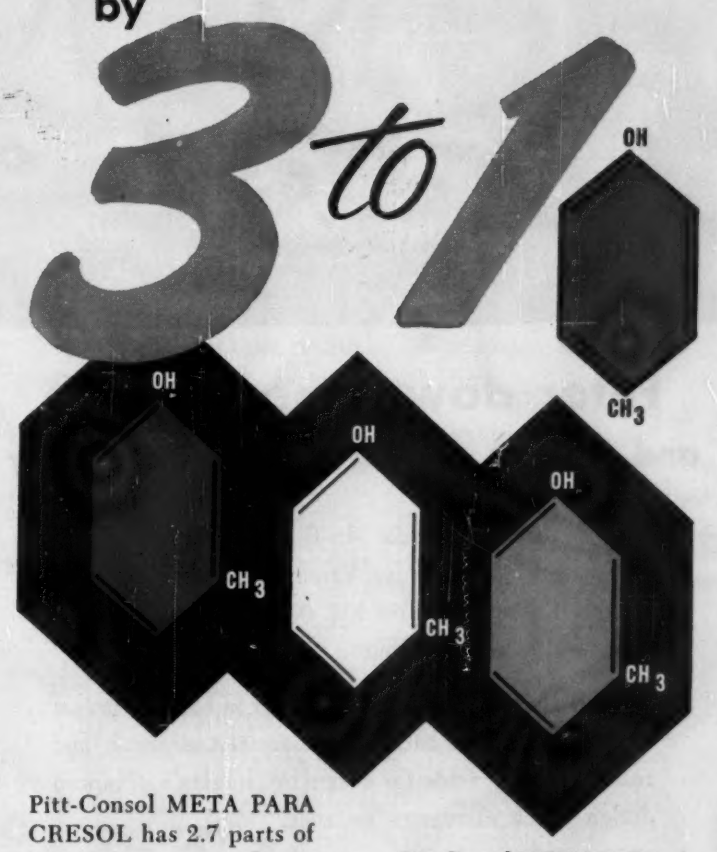

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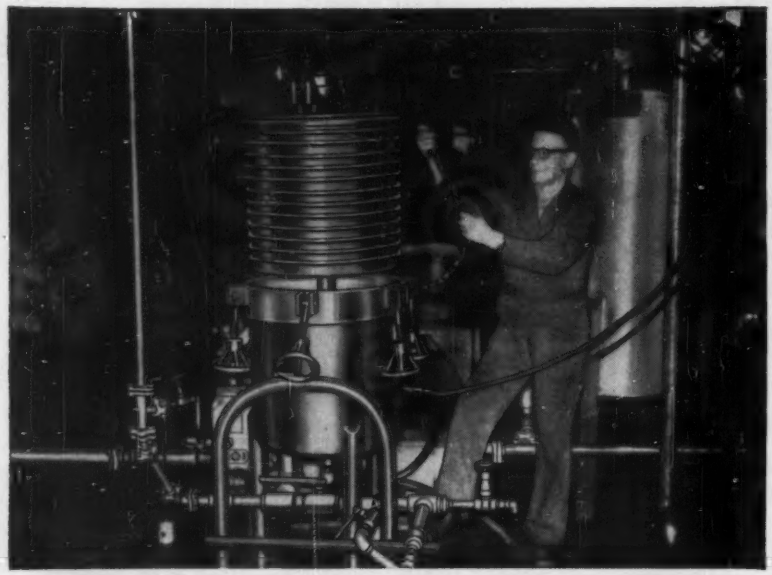

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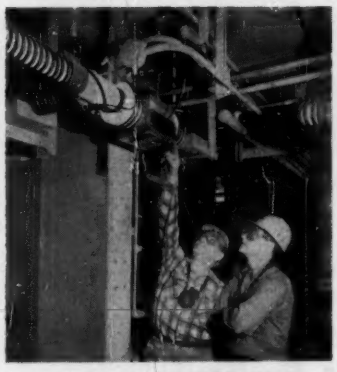
LETTERS:



More on Sodium Handling

Sir:

Your June 16 issue carried an article (p. 63) on bulk handling of sodium in Mallory-Sharon Metals Corp.'s new zirconium-titanium plant at Ashtabula, Ohio.

Much of the handling and purification equipment incorporated in this plant was developed as part of the Submarine Intermediate Reactor project. This project was concerned with development of a sodium-cooled nuclear reactor for submarine use. It was sponsored jointly by AEC and the Navy. The electromagnetic pump, magnetic flowmeter and low-temperature oxide filtration for sodium were brought to their present highly developed state as part of the submarine reactor project.

This is not intended to detract in any way from the undoubted contribution which U. S. Industrial Chemicals has made to the bulk handling of sodium.

B. G. VOORHEES
General Electric Co.
San Jose, Calif.

Con: Sacrosanct Secrets

Sir:

Your comments (June 2, p. 43) on the recent District Court decision where, as you state, "Court holds trade secrets sacrosanct," caused my temperature to jump dangerously. If this decision can be carried to a higher court, I feel that all our engi-

PRO & CON

C. H. CHILTON

neering societies should join to work for its reversal.

"Forever" is a long, long time. Court decisions in matters of this kind should be related to our patent laws, which establish a *limited* time reward for those who make some substantial discovery or invention. It would seem that Monsanto endeavors to nullify the time limit of patents and to monopolize forever a process through some obscure relationship with employees.

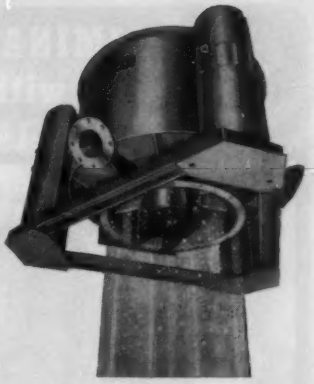
Any trade secret is the product of all the men working on the problem. The final process adopted may lack one or two ideas which a particular engineer could not sell to management. Is this individual to be prohibited forever from exploiting the process which, very possibly, would be greatly improved by his continued application to it? Is any individual to be prohibited from practicing in the field for which he is best suited because a corporation either did not choose to or could not obtain patent protection? In the patent field, our courts are much less friendly to monopoly.

Let us join and convince the courts that any trade secret, based merely on understanding, interpretation and application of published basic engineering facts, should have no standing in the courts, and that the very few trade secrets which have some special discovery as a reason for their being, be restricted in their protection to set contracts, specifying a reasonable time for non-disclosure, with a stipulated consideration for the employee's maintaining silence.

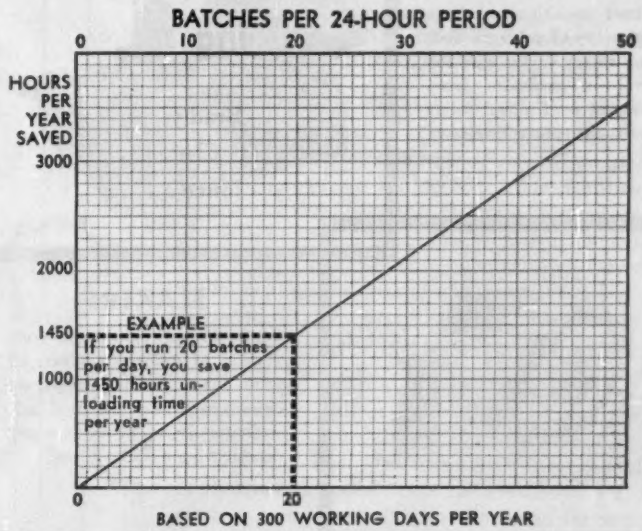
H. LESLIE BULLOCK
Engineering Consultant
New York, N. Y.

▶ *We have been exploring this broad, touchy question of trade secrets and confidential know-how for many months. See our You & Your Job feature for July 28 (pp. 127-130) and our Chementator story in this issue analyzing Judge Christenson's final decree in the Monsanto-Miller case.*—ED.

PREDICT the centrifuging hours you save in a year



This most revealing chart quickly shows how much unloading time you can actually save, with Batch-Master's® rapid bottom discharge and hydraulic unloader. The chart is based on Batch-Master's unloading time (30 seconds average) . . . as compared with that of a manually unloaded batch centrifugal (15 minutes or more). If the chart gives you a jolt, investigate Batch-Master.



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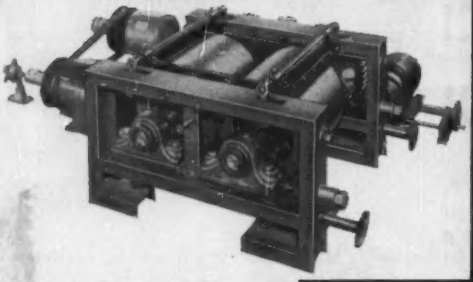

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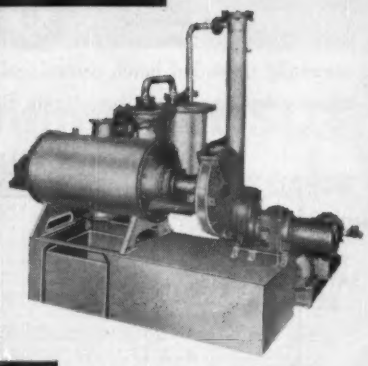

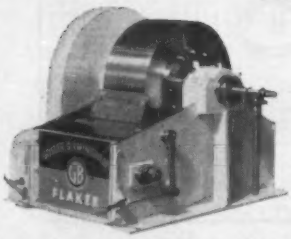

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TECHNICAL

Contents of This Issue

Chemicals & materials	164
Construction materials	167
Electrical & Mechanical equipment	169
Handling & Packaging	170
Heating & cooling	170
Instruments & Controls	174
Mechanical equipment	169
Pipe, fittings, valves	202
Process equipment	177
Pumps, blowers, compressors	179
Services & processes	189

Chemicals

Adipic Acid.....36 p. bulletin I-12R contains basic data for the researcher, including physical properties, chemical reaction, suggested use.
164A Allied Chemical Corp.

Alcohols, Acetylenic.....60 p. bulletin on methyl butynol and methyl pentynol covers physical properties, storage and handling, toxicity, analysis, uses, chemical properties.
164B Air Reduction Chemical Co.

Allyl Esters.....Data sheet covers complete line of allyl esters of mono-carboxylic acids and diallyl esters of dibasic acids. Includes novel functional group variations.
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Aluminas, Activated.....to solve your dehydration problems. It is nontoxic, noncorrosive & practically iron-free . . . it can be saturated & reactivated. Information avail.
39 *Aluminum Co. Chemicals Div.

Borohydrides.....34 p. manual of techniques covers properties, reactions and handling requirements of sodium and potassium borohydrides used in paper and pharmaceuticals.
164D Metal Hydrides Inc.

Calcium Cyanamide.....60 p. booklet shows how cyanamide's unique properties permit it to join with other chemicals in many ways as starting point for many compounds.
164E American Cyanamid Co.

Cetyl-Alcohol.....Special 99% pure is now on the market. Lead content is said to be 1ppm max., arsenic content 1 ppm max. Details in No. 1389.
101-102n *U. S. I. Chemicals Co.

Chemicals.....Tabulation of company's plasticizers, synthetic resins, pentaerythritol, formaldehyde, aromatic acid esters, nonionics. 8 p. bulletin.
164F Hercules Powder Co.

* From advertisement, this issue

LITERATURE

E. M. FLYNN

Chemicals.....for cleaning process equipment without dismantling, by in-place chemical circulation, using specialized materials & methods. Technical Bulletin.
188 *Oakite Products, Inc.

Chemicals, Aliphatic.....52 p. catalog contains test data on olefins, hydrocarbons, fatty alcohols, hydrogenated and vegetable fatty acids, glycerides, sperm oil products.
165A Archer-Daniels-Midland

Chloroacetaldehyde.....Revised technical manual includes sections on physical properties, reactions, toxicity, handling and use in pharmaceuticals, plastics.
165B Dow Chemical Co.

Dispersing Agent.....4 p. bulletin describes a retarding and stripping agent for the processing of textile fibers. Powerful dispersing agent, cleans paper machine felts.
165C Ciba Co.

Ethyl-di-n-propylthiolcarbamate..... is a selective herbicide for most grassy weeds . . . for use with crops such as beets, flax, corn, beans. For details, No. 1384.
101-1021 *U. S. I. Chemicals Co.

Ferrosilicon 15% (Atomized).....Technical data bulletin describing use in heavy media separation. Knapsack Griesheim, subsidiary of Farbwerke Hoechst.
165D Westco Chemicals, Inc.

Fluorine Gas.....A comprehensive 21-page technical bulletin "Fluorine" is available. Investigate the availability of fluorine as a liquid in bulk.
57 *Allied Chemical

Glycol di-mercaptoacetate.....a new dithiol, can act as a cross-linking agent & monomer for special polymerizations. Data given in No. 1387.
101-1021 *U. S. I. Chemicals Co.

Isophthaloyl & Terephthaloyl Chlorides.....of 98% minimum purity are suggested as raw materials for fibers, films, protective coatings. No. 1380.
101-102e *U. S. I. Chemicals Co.

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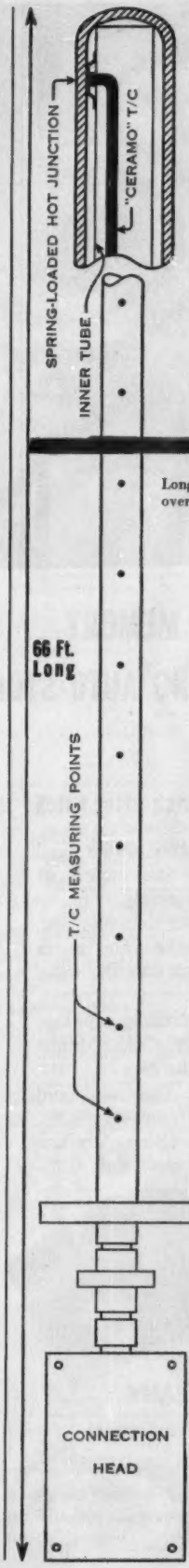
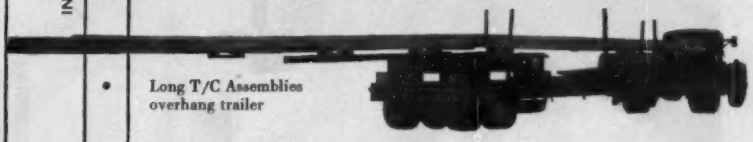


66 Ft. Multi-Thermocouple Shipped to South Africa

Three Long Multi-Thermocouples, Totaling 194 Feet Sent Across Ocean By Thermo Electric



Long T/C Assemblies overhang trailer

Thermo Electric makes thermocouples for just about every possible application—including some pretty unusual ones. The multi-thermocouple assembly diagrammed here is a good example. It's 66 feet long.

The longest of three, this assembly has a total immersion length of 63'7". The entire unit actually contains 12 different thermocouples—in progressively longer lengths from 9'1" to 63'7". These are enclosed in a 1½" I.P.S., Schedule 80 protection tube of type 304 Stainless Steel. Individual thermocouple construction is of T-E's "Ceramo"—ceramic insulated conductors encased in overall metal sheathing. O.D.'s are ⅛" with 22 gage Iron-Constantan conductors. Hot junctions are welded closed and, for fast response, are spring-loaded against the inner wall of the protection tube.

The three assemblies were sent by T-E to Durban, South Africa for installation in a catalyst reactor. They are typical of what Thermo Electric is currently doing in the field of temperature measurement. T-E equipment is being used all over the world for important temperature measuring jobs. Assemblies like this, used in deep vessels, will measure temperatures at any desired level. Thermo Electric also makes miniature thermocouples as small as ½" immersion length. Whatever your needs, for large or small thermocouples, for low or extremely high temperatures, for any type of application, contact Thermo Electric. Our extensive research, engineering and manufacturing facilities are at your disposal.

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LITERATURE . . .

Magnetism, Non-electric.....a 48-page booklet describes uses in modern materials handling & magnetic separation equipment. Covers chemicals, plastics, etc. #1381.
101-102f *U. S. I. Chemicals Co.

Meta Para Cresol.....is part of a full line of high quality phenols, cresols & cresylic acids produced by continuous extraction process. Data available.
161 *Pitt-Consol Chemical Co.

Metal-Ceramics.....New metal-ceramics, that show promise in high-temperature service where most metals or ceramics won't work alone, are covered in 12 p. booklet.
166A Haynes Stellite Co.

Methylene Chloride.....for use in such diverse applications as paint removers, aerosols, safety-type photo film, extraction, industrial cleaning. Literature available.
75.

Molecular Sieves.....can be used as latent accelerators & curing agents in a variety of rubber & plastics formulations including styrene-butadiene rubber. Data.
19 *Linde Products Co.

Monomers.....a line of methyl, ethyl & butyl acrylates for water base paints, for leather sealants, for textile sizing & for paper coatings. Technical service available.
71 *Celanese Corp., Chemical Div.

Nitric Acid.....If you are considering nitric acid or expanding your present facilities, descriptive literature & complete information on plants is offered.
48 *The Chemical & Industrial Corp.

Nylon.....For thermoplastic molding powder, 12 p. bulletin covers properties, processing information, injection molding, finishing operations.
166B Foster Grant Co.

Organometallic Compounds.....Best known are the Grignard reagents & tetraethyl lead. Organosodium compounds are being used as an economic route to other organometallics.
101-102b *U. S. I. Chemicals Co.

Persulfates.....For applications in processing color films, etching printing plates and modifying starches. Details in booklets Nos. 34 & 68.
29 Becco Chemical Division

Plastics.....Two 4 p. folders, "A New World of Molding Applications" and "A New World of Extrusion Applications" deals with Cycolac high impact thermoplastic.
166c Marbon Chemical

Polyethylene.....Chemical industry employs more & more polyethylene for equipment, packaging & protection; finds corrosion resistant properties most valuable.
101-102a *U. S. I. Chemicals Co.

Sodium.....Booklet "Handling Metallic Sodium on a Plant Scale" offers advanced techniques of sodium handling which have been developed over the years.
101-102d *U. S. I. Chemicals Co.

Solvents.....where odor is a problem use Sol 71 & 72 for polishes & cleaners, Sol 360 for fast evaporation, Sol for high flash, slower drying. Booklet.
59 *Shell Oil Co.

* From advertisement, this issue

FLEXIBLE...
RUGGED...
TOUGH
From Gases To Granules
PENFLEX Moves 'em All
It expands, contracts, absorbs vibration. It withstands abrasion, exposure. That's Penflex Tubing . . . it's flexible . . . made of bronze, galvanized or stainless steel in sizes (⅛" to 24" I.D.) and types to meet your conveying needs. Pennsylvania Flexible Metallic Tubing Company, Inc., 7234 Powers Lane, Phila. 42, Pa.
"Flexineering" illustrates the science of engineering tubing to your specific job.
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TIGHT AS A PIPE BUT...
FLEXIBLE

LITERATURE . . .

Solvents.....Solvesso Xylol gives uniformity & purity . . . for high resistance surface coatings of all kinds. Information on Toluol & Solvesso 100 & 150 available.
73 *Standard Oil Company, Inc.

Solvent recovery.....an efficient economical way to recover solvents vaporized in manufacturing processes such as: alcohols, ethers, chlorinated compounds, etc. Booklet.
L167 *Union Carbide Olefins Co.

Strippers.....4 p. leaflet describes compounds for the removal of extremely resistant surface coatings such as synthetic rubbers, vinyls, epoxies, urethanes, phenolics.
167A The Gregg Co.

Sulphur.....Stockpiling has always been a company policy. This enables routine or emergency shipments at any time, by any method, of any tonnage.
27 *Texas Gulf Sulphur Co.

Urethane Foams.....Glass fibers improve compression properties of polyurethane foams . . . per cent elongation is reduced without affecting density or porosity.
101-102c *U. S. I. Chemicals Co.

Vinylpyrrolidone.....25 p. brochure on applications is profusely illustrated with technical tables and charts. Details copolymerization with other monomers.
167B General Aniline & Film Corp.

Construction Materials

Adhesive.....new for bonding polyethylene linings to steel tanks & other surfaces. Bonds are temperature-stable, remain flexible. Request No. 1382.
101-102g *U. S. I. Chemicals Co.

Alloys.....especially resistant to the halogens. A 104-page booklet gives information on alloys, their properties, forms & the corrosives they will resist.
143 Haynes Stellite Co.

Castings, Alloy.....Up-to-date catalog describes the best alloying combination to solve your corrosion, high temperature & abrasion problem.
178 *The Duraloy Company

Carbon & Graphite.....used for high temperature chemical processing equipment. These materials provide almost universal corrosion resistance & structural stability.
46a *National Carbon Co.

Coatings.....Use of rubber latices as greaseproof coatings on papers and as saturants for paper is discussed in 20 p. Hycar Latex Newsletter, Issue No. 17.
167C B. F. Goodrich Chemical Co.

Coatings.....Corrosion-resistant coatings listed by type, color, coverage, description & recommended uses, etc. For details and data sheet request Bulletin 258.
167D
Wisconsin Protective Coating Co.

Coatings, Protective..... Tygorust primer provides excellent adhesion to dry or damp rusted steel. Tygon hot spray is ideal equipment coating. Manual for details.
50 *U. S. Stoneware

* From advertisement, this issue

SOLVENT RECOVERY CUTS COSTS

SAVE 65% TO 80% ON PROCESS SOLVENT COSTS

Solvent recovery by the COLUMBIA Activated Carbon system can cut manufacturing costs in any operation where low-boiling organic solvent vapors can be collected. For instance . . .

- *Acetate fiber manufacture*
- *Coating operations*
- *Rotogravure printing*
- *Plastics processing*
- *Rubber products manufacture*
- *Pharmaceutical production*
- *Dry cleaning*
- *Metal degreasing operations*
- *Solvent extraction*
- *Manufacture of smokeless powder*

Solvent recovery is the efficient, economical way to recover solvents vaporized in manufacturing processes. What solvents can be recovered? Well, alcohols, esters, ethers, ketones, hydrocarbons, chlorinated compounds, and practically all mixtures of these solvents can be recovered and reused. And look at these facts . . . *recovery plant efficiency—more than 99%: cost of recovery—1 to 2¢ per pound.*

This means that the initial cost of solvents becomes a secondary consideration because they can be used over and over again. Fire and health hazards are reduced, too!

CARBIDE can tell you how a solvent recovery plant can efficiently and economically recover your process solvents. Write now for the booklet, "Solvent Recovery by the COLUMBIA Activated Carbon System." Address Department B, Union Carbide Olefins Company, 30 East 42nd Street, New York 17, New York.

UNION CARBIDE

UNION CARBIDE OLEFINS COMPANY

Division of Union Carbide Corporation

30 E. 42nd Street, New York 17, N. Y.

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GET THE JUMP ON FIRE
with Kidde extinguishing equipment!

PORTABLE EXTINGUISHERS

Left to right: carbon dioxide trigger, carbon dioxide squeeze valve, 2½ gallon foam, 2½ gallon pressurized water, 20-pound pressurized dry chemical, 20-pound cartridge-operated dry chemical, 2½ gallon pump tank, one quart pressurized VL. Also 1 gallon pressurized VL and 1 and 1½ quart pump VL.

Kidde hand portables are designed to knock fires out *fast*, come in a variety of types and models. The Kidde line includes carbon dioxide extinguishers with fast-acting trigger release or squeeze-valve release in capacities of 2½ to 20 pounds. Kidde dry chemical extinguishers can be had in pressurized models of 5, 10, 20 and 30 pounds capacity, and in cartridge-operated models of 20 and 30 pounds. Kidde wet chemical extinguishers (foam, soda-acid) are available in 2½ gallon bronze or stainless steel models, including cartridge-operated and pressurized water or water-anti-freeze units. Kidde vaporizing liquid extinguishers come in pump capacities of 1 and 1½ quarts, pressurized in 1 and 1½ quarts and 1 gallon. Kidde pump tank extinguishers, in steel or copper shells, are available in 2½ and 5-gallon sizes.

MOBILE EQUIPMENT

Left to right: 100-lb. carbon dioxide, 150-lb. dry chemical, 40-gal. foam. Also 40-gal. soda-acid.

For major fire hazards, get a mobile unit. Wheeled carbon dioxide units are available in 50, 75, and 100-pound capacities, in one cylinder. Shut-off valve located at nozzle gives operator complete control. 150-pound dry chemical unit has straight stream for long range... fan pattern for wide coverage. Single-lever control for "on," "off," "fan," or "straight" discharge pattern, 50 feet of hose. 40-gallon wheeled foam unit delivers more than ten times its liquid content capacity in fire-smothering foam. Ideal protection against flammable liquid fires. All give expert results even with inexperienced operator.

SMOKE AND FIRE DETECTORS, CARBON DIOXIDE SYSTEMS

Kidde Industrial Smoke Detectors give you a fire warning where it counts—at the smoldering start of a fire—tell you fire's location, give you a visible and audible alarm.

Kidde Atmo fire detecting and warning systems afford wide-area protection, are ideally suited for cases where early detection of fire in valuable materials is essential. Working on the principle of rate-of-temperature-rise, Kidde Atmo systems give warning at the first hot breath of fire, can be used to shut off fans, close doors, etc.—all automatically.

Kidde carbon dioxide extinguishing systems are individually designed to fully protect even the most dangerous hazards, use pneumatic control heads to insure instant and complete carbon dioxide discharge. Directional valves afford protection to more than one hazard using the same bank of cylinders. All operating parts are self-enclosed for safety. Visual indicators show at a glance if system is "set" or "released." Thermostatically-operated systems, and package systems for 6000 cubic foot flammable liquid hazards are available.

Kidde

Walter Kidde & Company, Inc.
828 Main St., Belleville 9, N. J.
Walter Kidde & Company of Canada Ltd.
Montreal—Toronto—Vancouver

LITERATURE . . .

Floors, Industrial.....resistant to widest range of acids, alkalies & solvents. Constructed of acid brick & joined with corrosion proof cement. Bul. 3-3.
R175 . *Atlas Mineral Products Co.

Polysulfide Rubber.....Three new caulking compounds are available which are said to have 400 to 500% elongation & flexibility. Used on metals, wood, etc. #1385.
101-102j *U. S. I. Chemicals Co.

Primers.....Amercoat #86 resists undercoating & adheres tenaciously, inhibiting electrolytic corrosive action. Data available for use on your next coating job.
87 *Amercoat Corp.

Rubber Materials.....For the Chemical Process Industries a complete line of corrosion-resistant materials, equipment & services. Hard rubber pumps, pipe, fittings & valves.
L175 *The Luzerne Rubber Co.

Solvent Stripper.....Non-flammable for newer expoxies usually difficult to remove. Coatings are rapidly wrinkled & detached from base, rather than dissolved. No. 1388.
101-102m *U. S. I. Chemicals Co.

Stearates.....Zinc stearate & calcium stearate are used as internal & external lubricants. Aluminum stearates used in greases & paints. Industrial price list offered.
R153 *Mallinckrodt Chem. Works

Steel Aluminized.....Produced in two grades Type 1 & 2 which provide a range of useful properties. Both have good heat reflectivity plus resistance to fire damage. Lit.
47 *Armco Steel Corp.

Steel, Stainless.....A complete selection of literature is available on different sizes, shapes & finishes. Publication list describes over 150 technical pieces.
52 *Allegheny Ludlum Corp.

Steel, Stainless.....widest selection & range of stainless types, shapes & sizes. Big capacity abrasive saw assures cutting accuracy, also flame-cutting facilities.
112 *Ryerson Steel

Tantalum..... "Corrosionomics", a journal of useful information for the solution of corrosion problems. Technical data on Tantalum, its uses & properties.
R159 *Fansteel Metallurgical Corp.

Titanium.....Technical bulletins on titanium's properties & advantages are available. Gives applications and solutions to special problems.
95 *Mallory-Sharon Metals Corp.

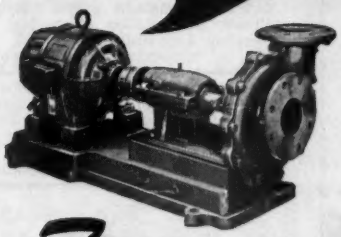
Titanium Tubing.....Data book describes physical and mechanical properties, fabrication characteristics, and corrosion resistance of titanium tubing and piping.
168A Carpenter Steel Co.

Wire Cloth.....A 94-page catalog & stock list gives the full range of wire cloth available, describes fabrication facilities & gives useful metallurgical data.
R177 *Cambridge Wire Cloth Co.

Wire Cloth & Screen.....resists distortion, corrosion, heat & pressure. Condensed Screen Reference Catalog gives specifications and other details.
174 *Ludlow-Saylor Wire Cloth Co.

* From advertisement, this issue

Custom-built for
EFFICIENT
DEPENDABLE
SERVICE



Frederick

SSV PUMPS

Enclosed Impeller and Open Impeller Types

You're sure of maximum service and output with minimum maintenance or production down time with Frederick SSV Centrifugal Pumps because each pump is custom-made to fit your particular operation—whatever the consistency or type of liquid you're moving.

SSV PUMP FEATURES

- **Pump sizes from 1" to 4" discharge openings.**
- **Pump capacities from 50 up to 700 U.S. GPM.**
- **Heads from 30 up to 220 feet.**
- **Pumps speeds can be varied to suit the driving media and operating conditions.**

CONSTRUCTION ADVANTAGES

Pump casings are vertically split for easy accessibility. Mounted on a swivel to permit placing discharge in any desirable position. Pump openings, both suction and discharge, flanged to permit easier connection and disconnecting to joints. One-piece impellers, securely attached to shaft by stout key and lock nut, or threaded, give long service. Pump bearings mounted in sturdy frame horizontally split for easier accessibility. Extra long stuffing box provides for oversize stuffing. Mechanical seal also available for minimum leakage. Pump coupling flexible for direct connection to drivers or can be arranged for belt drive. Pump speed, pump openings, etc. are selected to suit your particular requirements.

Write for Bulletin No. 107

FREDERICK PUMPS

FREDERICK IRON AND STEEL, INC.
FREDERICK Est. 1890 MARYLAND

LITERATURE . . .

Electrical & Mechanical

Couplings.....for safe transfer of chemicals get Ever-Tite quick couplings. Efficient & economical service, whatetver the need or application.
B148 *Ever-Tite Coupling Co., Inc.

Cutters, Knife.....Bulletin App. 216 gives details on designs, sizes and speeds of the 700 series. Main bearings are available in different types.
169A Taylor, Stiles & Co.

Drives, Helical Gear.....New 6-page supplement contains complete data on horsepower ratings, dimensions, and other information relating to in-line helical gear drives.
169B Link-Belt Co.

Motors.....Explosion-proof chemical motors built with cast-iron housings to provide exceptional corrosion resistance to etching vapors & corrosive gases. Bul. 1050.
139 *The Louis Allis Co.

Motors.....For any drive requirements with power drive features, speeds installation and construction. Ratings ⅛ to 400 H.P. All phases, voltages and frequencies.
189 *Master Electric Co.

Motors.....All windings are insulated with asbestos, shock-resistant, corrosion-resistant cast iron frames that are heat-seasoned to prevent warp. Color Brochure.
89 *U. S. Electrical Motors, Inc.

Motors, Tube Ventilated.....For big fans, blowers, pump drives . . . heavy duty applications where you need large motors with highly effective cooling systems.
40 *Wagner Electric Corp.

Precipitators....The Koronamax electrodes increase efficiency & capacity of electrostatic precipitators. May solve your gas cleaning problem. Information available.
67 *Koppers Company, Inc.

Reactors.....Supplied with new Glasteel 59 which gives you added insurance against thermal shock. Sizes & specifications are available on request.
190 *The Pfaudler Co.

Rectifiers, Silicon.....approximately 95% overall efficiency for low & medium voltage applications. Draw-out construction makes replacement quick & easy. Information.
14-15 *Westinghouse Electric Corp.

Sampling Devices.....Booklet contains more than 35 illustrations dealing with the subject of selection and application of electronic and mechanical samplers.
169C General Devices, Inc.

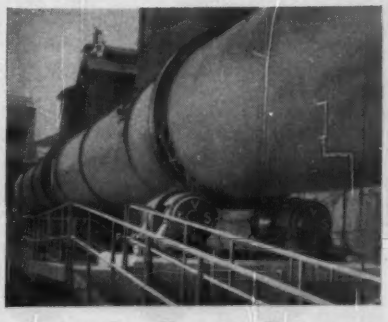
Switch, Interrupter.....Power switching centers with interrupter switches are built for safter operation—even against short circuits. Complete information available.
26 *I-T-E Circuit Breaker Co.

System, Electrical.....For a new plant or to expand facilities, technical assistance & engineered equip. is available, including transformers, circuit breakers & motors.
10-11 *General Electric Co.

* From advertisement, this issue

KENNEDY ROTARY KILNS *for*

Lime
Calcined Coke
Dead Burned Dolomite
Cement—Wet or Dry Process
Nodulizing and Agglomerating
Drying



Compare these KENNEDY *Features:*

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- Stationary firing hood with swinging entrance ports for quick, easy internal access.
- Truly effective air seals.
- Drive gear mountings avoid thermal stresses.
- Built in any length or diameter.
- Designed to give economical, efficient operation over long periods.

FOR ADDED ECONOMY—Preheaters for your new or existing kilns: KENNEDY Multivane Internal Recuperator—KENNEDY-Grudex Preheater—KENNEDY External Stone Preheater.

Suppliers to the Chemical Industry of crushing, grinding and pulverizing machinery, complete cement and lime plants, size separation equipment and pneumatic conveying components and systems.

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MANUFACTURING & ENGINEERING CORPORATION
405 Park Ave., N. Y. 22, N. Y. • Factory: Danville, Pa.

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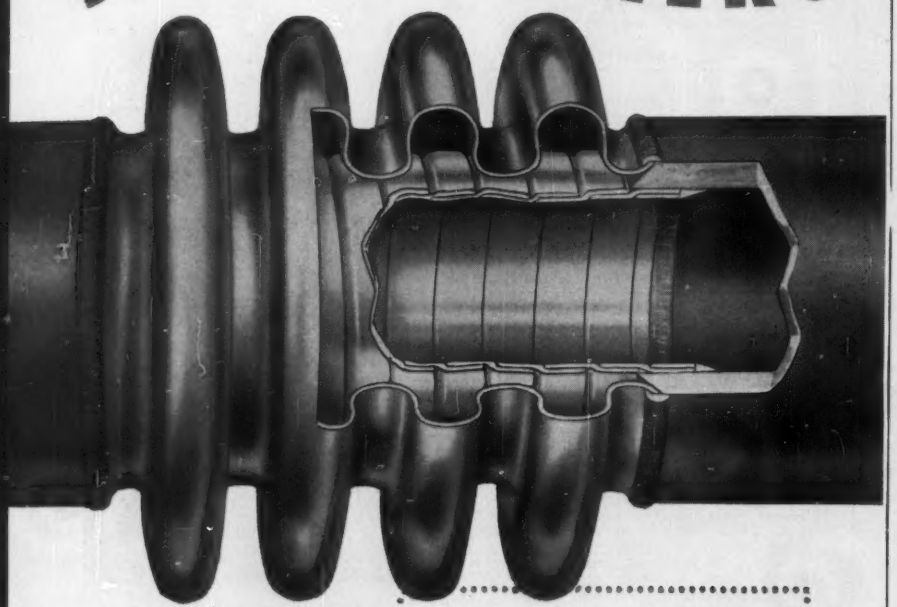
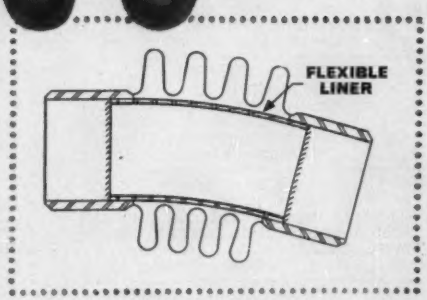
EXPANSION JOINTS *NOW* WITH

FLEXIBLE LINERS



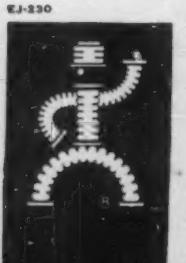


Lateral or angular motion without flow reduction of conical type liners

No more need to specify oversize expansion joints to allow for the flow reduction through an ordinary conical liner! Now you can get Flexon Expansion Joints with flexible liners that give full flow. Easier to install, too, because flow can be in either direction. A section of smooth interior, Flexon stainless steel hose forms the liner—cuts flow turbulence, reduces carrier temperature and permits full pipe movement either laterally, angularly, or axially. The cost is no more than for conical sheet liners.

Write today for facts about this new Flexon development—and your copy of the 28-page Flexon Expansion Joint Design Guide, the complete handbook for solving every problem in pipe motion.

EJ-230



Flexonics corporation

EXPANSION JOINT DIVISION • 1317 S. THIRD AVENUE, MAYWOOD, ILLINOIS

EXPANSION JOINTS · METAL HOSE · NON-METALLIC HOSE · BELLOWS · AIRCRAFT COMPONENTS

LITERATURE . . .

Thermocouples, Multi-.....Whatever your needs, for large or small thermocouples, for low or extremely high temperatures, for any type application. Details.
165 *Thermo Electric Co., Inc.

Turbines.....Exclusive pilot operated excess speed safety trip supplementing constant speed governor; choice of metallic or carbon ring packing assemblies. Bul. 135.
43 *Coppus Engineering Corp.

Turbines, Steam.....A complete line of turbines for all applications & operating conditions from 5 to 2000 H.P. Details on solid-wheel type in Bul. S-116.
108 *The Terry Steam Turbine Co.

Handling & Packaging

Container, Corrugated.....Has interlocking tube and cap construction secured by steel strapping incorporated inside the box. Eliminates closing equipment, adhesives.
170A Gaylord Container Corp.

Conveyor, Roller.....Bulletin contains typical applications, explains construction features, tells how to select roller conveyors. List of accessories.
170B Rapids-Standard Co., Inc.

Conveyors, Tubular.....for moving almost any flowable material-wet or dry through any plane or angle. Dust & liquid tight. Catalog C-858 is offered.
TL149 *Hapman Conveyers, Inc.

Feeders, Rotary Airlock.....New 12-page technical manual on manufacturer's line explains selection, operation and application. Specifications and drawings.
170C Prater Pulverizer Co.

Loader.....Model TL-6 has the short, 6½ ft. turning radius & power steering. A descriptive catalog on the complete line of Tractoloaders is offered.
93 *Tractomotive Corp.

Materials Handling.....Complete data on the new model H-25 Payloader available. Handles more material per hour at less cost per ton. Carry capacity of 2,500 lbs.
8 *The Frank G. Hough Co.

Microfilm Storage.....is the subject of a new American Standard, drawn up for the purpose of protecting against humidity, temperature, dust & gas. No. 1383.
101-102h *U. S. I. Chemicals Co.

Weighing System.....The new Bul. 582 describes in detail the Way-Pac line of low-capacity, low-price packaged systems for tank weighing & figuring costs.
25 *A. H. Emery Co.

Heating & Cooling

Boilers.....available in 19 sizes, 130 models, 15 to 600 hp. . . . steam or hot water, gas, oil, or combination oil/gas fired. Facts on the self-contained boiler offered.
156 *Cleaver-Brooks Co.

* From advertisement, this issue

(*Continued on p.* 174)

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4	25	37d	49	74C	80A	93	101-102k	145	154A	R159	165B	168A	176	R179
6	26	37e	50	75	80B	94	101-102l	147	154B	160	165C	L169	176A	180
7	27	38a	52	76A	80C	95	101-102m	T148	155	161	165D	R169	L177	180A
8	28	38b	54-55	76B	80D	96	101-102n	B148	155A	162	166	169A	R177	180B
9	29	38c	57	76C	81	101-102a	103	TL149	156	163	166A	169B	177A	180C
10-11	30	39	59	76D	82	101-102b	108	BL149	156A	164	166B	169C	177B	180D
14-15	31	40	63	76E	83	101-102c	109	R149	156B	164A	166C	170	177C	180E
16-17	32	41	65	76F	84	101-102d	110	150	157	164B	L167	170A	178	186
18	33-34	42	67	76G	85	101-102e	112	151	157A	164C	R167	170B	178A	187
19	35	43	69	77	86	101-102f	135	152	157B	164D	167A	170C	178B	188
20	36	44	71	78A	88	101-102g	137	TL153	158	164E	167B	174	178C	189
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22	37a	46a												

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4	21	22	26	28	33	35	36	37	38	40	42	45	46	47	48	49	50	52	54	55	57
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4	25	37d	49	74C	80A	93	101-102k	145	154A	R159	165B	168A	176	R179
6	26	37e	50	75	80B	94	101-102l	147	154B	160	165C	L169	176A	180
7	27	38a	52	76A	80C	95	101-102m	T148	155	161	165D	R169	L177	180A
8	28	38b	54-55	76B	80D	96	101-102n	B148	155A	162	166	169A	R177	180B
9	29	38c	57	76C	81	101-102a	103	TL149	156	163	166A	169B	177A	180C
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14-15	31	40	63	76E	83	101-102c	109	R149	156B	164A	166C	170	177C	180E
16-17	32	41	65	76F	84	101-102d	110	150	157	164B	L167	170A	178	186
18	33-34	42	67	76G	85	101-102e	112	151	157A	164C	R167	170B	178A	187
19	35	43	69	77	86	101-102f	135	152	157B	164D	167A	170C	178B	188
20	36	44	71	78A	88	101-102g	137	TL153	158	164E	167B	174	178C	189
21	37	45	73	78B	89	101-102h	139	BL153	158A	164F	167C	174A	178D	190
22	37a	46a												

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85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	107
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Interpreting Kinetics (50¢).... 66
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LITERATURE . . .

Condensers.....Disc-Flow Barometric condensers for condensing steam & creating a vacuum wherever condensate is expendable. Ejector-jet type available. Bul. 9012A.
L179 *Ingersoll-Rand

Condensers, Vapor.....gives more capacity at a saving of steam & power. Unit capacities up to 15 million BTU. For full information request Bulletin 129R.
B149 *Niagara Blower Co.

Evaporators.....Septuple Effect unit evaporates 6.3 lbs. of water per lb. of steam. Details in Catalog 372. Catalog 381 discusses Customer Service Laboratory.
45 *Blaw-Knox Co.

Heat Exchangers.....The extended surface offers greater heat capacity. Production facilities and design research offered throughout the chemical industry.
160 *Aerofin Corp.

Heat Exchangers.....Readily assembled to handle any combination of liquids & gases. Can be used as a heater, cooler, condenser or vaporizer. Bulletin 302.5K1.
35 *American Standard

Heater, Steam.....Heat & agitate liquids in tanks, efficiently & economically. Bul. 3A-HC includes application information & data on sizes, dimensions & capacities.
37 *Schutte & Koerting

Kilns, Rotary.....Feature; self-aligning bearing pedestals, truly effective air seals & stationary firing hood. Built in any length or diameter.
R169 *Kennedy Van Saun Corp.

Kilns, Rotary.....for calcining, roasting, chlorodizing, volatilizing, sintering & nodulizing. Heavy steel plate shells are automatically welded together.
38 *Traylor Engineering & Mfg. Co.

Steam Trap.....Operates on a few degrees of temperature differential. Give effective condensate removal. Each unit service tested. Factual details offered.
82 *Nicholson & Co.

Thermo-Panels.....take the place of pipe coils. A 52-page Bulletin #355 gives technical data while Bulletin 258 covers design and price information.
T148 *Dean Products Inc.

Instruments & Controls

Analyzers, Gas.....Continuous analysis of one component in multi-component gas mixtures. Write for bulletin on this inexpensive thermal conductivity analyzer.
83 *Mine Safety Appliances Co.

Analyzer, Oxygen.....Analyzes and continuously records minute quantities of oxygen dissolved in feedwater for steam generating plants. Bul. 148.
174A Cambridge Instrument Co.

Controls, Liquid.....Meters & accessories offer complete systems for every type of liquid control. Complete information illustrating the types of systems is offered.
94 *Bowser, Inc.

* From advertisement, this issue

For Chemical Process Industries

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Of Complete Corrosion-Resistant Materials, Equipment and Services

PVC & OTHER CUSTOM MOLDED PLASTICS

Specializing in intricate, heavy parts; metal inserts molded in.

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New uses, new compounds of this reliable chemical-resistant material.

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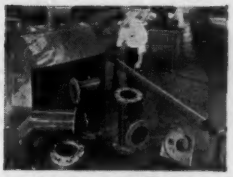

Unlimited applications and versatility for this fine plastic—rigid polyvinyl chloride.

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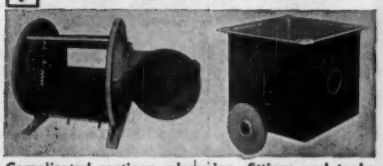

Complicated castings, also pipe, fittings and tanks lined to specification.

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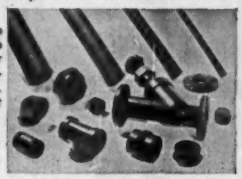

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LITERATURE . . .

Controls, Vacuum & Pressure.....The J6K contains a single switch, the J27KB is a dual switch control. Both offer system differential up to 90 psi. Details available.
176 *United Electric Controls Co.

Meter, Auto-Stop.....capacities 5 to 300 gpm. Features include ticket-printing registers & electrical Auto-Switch to control pumps, valves or signals. Bul. 566-O.
166 *Neptune Meter Company

Meters, Gas.....Servicing is limited to lubrication of bearings & gears and an occasional check of the operating differential. 39 sizes offered. Bul. M-152.
154 *Roots-Connersville Blower

Recorders.....On a single chart you can measure four variables. Same instrument is designed to accommodate plug-in control units. Information on request.
44 *Bailey Meter Co.

Systems.....Folder N-0720(1) "Modern Practices in Rotary Kiln Instrumentation", has 16 illustrated pages on instrument & control systems for your operation.
32 *Leeds Northup

Viscometers.....Viscosity can represent a fundamental property which will determine a fluid's ultimate composition or quality in use. Information on instruments offered.
R149 *Brookfield Engineering Lab.

Pipe, Fittings, Valves

Fittings, Welding.....in sizes ½" through 24" . . . stainless steel, monel, nickel & aluminum types. Seamless fittings with all plus values.
6 *Flowline Corp.

Fittings & Flanges.....now with individual packaging in rugged containers to protect against damage. Each container marked with size, type material & production lot.
Cover
*Tube Turns, Div. of Chemetron

Gaskets, Chemiseal.....made with a variety of filler constructions to suit every connection problem & every pipe & nozzle material requirement. Bul. AD-154.
155 *U. S. Gasket Co.

Joints.....provide safe easy handling of liquid missile fuels, for use in nuclear, missile & industrial applications. A new pamphlet describes the complete line.
22 *Solar Aircraft Co.

Joints, Expansion.....Offer lateral or angular motion without flow reduction of conical type liners. New 28-page Expansion Joint Design Guide is available.
170 *Flexonics Corp.

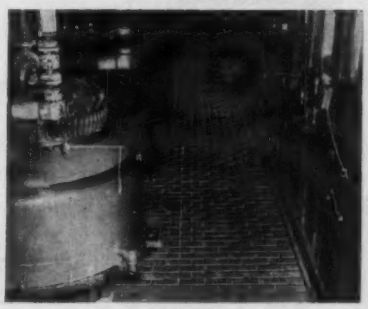
Nozzles.....for oil atomizing, air washing, spray ponds, acid chambers, concrete curing and milk powdering. Information on nozzles for all spray problems in Catalog 1.
L159 *Monarch Mfg. Works, Inc.

Pipe, Aluminum.....now a complete corrosion-resitant pipe that welds rapidly & easily. Won't contaminate or discolor fluids. Literature is available.
41 *Reynolds Metals Co.

* From advertisement, this issue

Atlas

INDUSTRIAL FLOORS STOP CORROSION



. . . in chemical processing areas!

Atlas Industrial Floors in your chemical processing areas will permanently stop corrosive attack . . . not merely retard or control it. They are resistant to the widest range and concentrations of acids, alkalies, salts and solvents.

These floors are constructed of acid brick laid on an impervious membrane and joined with Atlas corrosion-proof cement. There is a wide choice of cements available . . . each to solve a specific problem.

Atlas floors are engineered to withstand all types of physical abuse from heavy static loads to constant truck traffic.

Make an Atlas Floor your permanent corrosion-proof base for operations.

Write for Bulletin 3-3 for complete details.

For nearest Branch Office see our advertisement in Chemical Engineering Catalog.

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MERTZTOWN, PENNSYLVANIA

Sensitive

J6K J27KB

DIFFERENTIAL PRESSURE and VACUUM CONTROLS

By using **UNITED ELECTRIC's** Type J6K or Type J27KB control, it is possible to control accurately the difference in pressure between two pressure or vacuum sources. The J6K contains a single switch; the J27KB is a dual switch control.

System Differential	Up to 90 psi.
Switch Differential	J6K — can be set between limits of ½" Hg and 3 psi. J27KB — can be set between limits of 1" Hg and 5 psi.
Switch Ratings	15 amps. at 115 or 230 volts A.C. Also 20 amps. or D.C. switches on specification.
Switch Types	N.O., N.C., or Double Throw — no neutral position.
Adjustments	J6K — internally located, uncalibrated adjustment wheel. J27KB — each switch has independent, uncalibrated adjustment screw.
Electrical Connections ..	Made to screw terminals on switches through clearance hole in enclosure.
Pressure Connections ..	Two ¼" female NPT pressure connections.
Size	J6K — 7 5/32" x 4 27/32" x 2 5/16". J27KB — 7 1/16" x 6 1/8" x 2 7/8".
Approximate Weight ...	J6K — 2¼ lbs. J27KB — 2 lbs.

UNITED ELECTRIC *manufactures a complete line of temperature, pressure and vacuum controls. Standard units can be modified or custom-built units made to your specifications. Additional information on pressure and vacuum controls is available upon request.*

UE ®

United Electric Controls COMPANY

84 SCHOOL STREET, WATERTOWN, MASS

LITERATURE . . .

Pipe, Plastic.....Precision molded pipe & fittings for every corrosion & flow problem include tees, couplings, flanges, reducing bushings, plugs, etc.
147 *U. S. Rubber Co.

Pipe & Fittings..... are immune to the corrosive action of most acids, liquids and gases. Smooth interior walls minimize build up of deposits, assuring free-flow.
TL153 *Mueller Brass Co.

Pipe & Fittings.....Data on Fluoroflex-T type S pipe & fittings is available. Corrosion-proof for service to 500 F in chemical & corrosive solutions.
137 *Resistoflex Corp.

Safety Head.....When pressure-relief requirement is greater than the discharge capacity of the valve, the Safety Head provides an instantaneous, unrestricted opening.
158 *Black, Sivalls & Bryson, Inc.

Tubes, Pressure..... available in all stainless & alloy grades to meet almost any combination of operating conditions. Available in sizes up to 11"O.D. x 3" wall.
21 *Timken Roller Bearing Co.

Tubing.....Truflin types S/T, the integrally finned tube for shell & tube heat exchangers. Detailed breakdowns in cost differentials explained in new book.
91-92 Calumet & Hecla, Inc.

Tubing.....made of bronze, galvanized or stainless steel in sizes ⅛" to 24" I. D. "Flexineering" illustrates the science of engineering tubing to your specific job.
R167
*Pennsylvania Flexible Tubing.

Valve.....Folder No. 207 describes the Outside Screw & Yoke U-Bolt Gate valve . . . All-Iron & Ni-Resist with type 316 Stainless Steel trim.
85 *Jenkins Bros.

Valves.....The flexible wedge disc valve minimizes the possibility of seat leakage caused by line strains, uneven temperature or pressure conditions. Details.
109 *Crane Co.

Valves.....The Reverse Flow relief & by-pass valve is used in booster installations to prevent excess build-up of pressure. Three types described in Bul. 6600.
176A Norwalk Valve Co.

Valves.....All kinds & types available in a variety of Nickel & Monel. Able to handle every flow requirement. Information on all models is available.
141 *The Wm. Powell Co.

Valves.....The GP type are available in a range of sizes from ¼" to 2" & rated 800 lbs. at 850°F & 2000 lbs. at 100°F. Details in Supplement 1 to Catalog F-9.
135 Henry Vogt Machine Co.

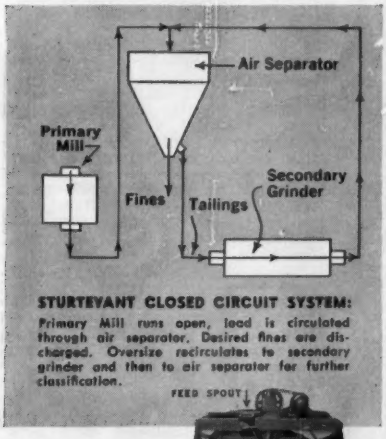
Valves, Ball.....Double-Seal ball valves handle a wider range of liquids and gases. They take care of acids, abrasives, chemicals, solvents, etc. Literature.
152 *Jamesbury Corp.

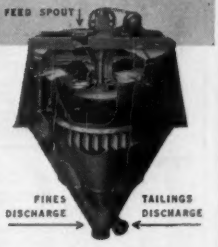
Valves, Control.....Super 70 diaphragm valves are available in either clamp ring, float ring, sealed bonnet or flanged-gasketed body closures. Information offered.
96 *Black, Sivalls & Bryson, Inc.

* From advertisement, this issue

STOP OVERWORKING GRINDING MILLS

Boost Production of 40 to 400 Mesh Fines As Much As 300%


Air Separator
Primary Mill
Secondary Grinder
Fines
Tailings
STURTEVANT CLOSED CIRCUIT SYSTEM:
Primary Mill runs open, load is circulated through air separator. Desired fines are discharged. Oversize recirculates to secondary grinder and then to air separator for further classification.



Current users of Sturtevant Air Separators include manufacturers of sulfur, soybeans, phosphate, chocolate, feldspar, sand, pigments, limestone fillers, abrasives, plasters, ceramics and cement.

Sturtevant Air Separators Can Lower Power Costs Up To 50%

Production capacity impossible in single-pass grinding results from using Sturtevant Air Separators in closed-circuit grinding systems. They are of proved advantage in all secondary reduction processes.

Fines pass through grinding mills unhindered, are classified, and the oversize returns for further grinding. Grinding mills are free to perform at top efficiency, their output frequently increased as much as 300% and power costs cut up to 50% (documented by 30 years of Sturtevant air separation experience in the cement industry).

Precise Classification; Circulates Loads of 800 tph

Sturtevant Air Separators circulate production loads of up to 800 tph. Simple adjustments make possible counter-action between air currents and centrifugal force to the point where a product of almost any desired fineness may be collected while coarser sizes are rejected.

A 16 FT. STURTEVANT, for example, took a feed rate of 800 tph, containing only a small percentage of desired fines, and delivered 30 tph 90% 200 mesh, recirculating the oversize through the grinding circuit. (In the cement industry, Sturtevant units deliver up to 60 tph raw cement fines, 40 tph finished cement fines.)

Nine models available, diameters from 3 to 18 ft. For more information, request Bulletin No. 087. (Bulletins also available on Micronizers, Blenders, Crushers, Grinders.) Write STURTEVANT MILL CO., 100 Clayton St., Boston, Mass.

LITERATURE . . .

Valves, Plug.....sealed by tough, film of pressurized lubricant & seats are never exposed to the line. A complete line of accessories are available. Literature.
32-34 *Rockwell Mfg Co.

Valves, Relief.....for relieving gas or liquid under pressure or vacuum & for maintaining constant pressure on lines, holders & tanks. Bulletin 6500
177A Norwalk Valve Co.

Valves, Steel Gate.....The flexitallic gasket in the bonnet joint of this valve cannot blow out even if pressures exceed ten times the rating of the valve. Details.
24
***Manning, Maxwell & Moore, Inc.**

Process Equipment

Bucket Elevators.....2 types designed for maximum efficiency; internal discharge handles fragile materials such as pellets, centrifugal discharge handles loose materials.
7 *Link-Belt Co.

Centrifugals.....A catalog is offered on the time-saving Batch-Master centrifugal. Fast bottom discharge & hydraulic unloading save processing cycle time.
163 *Amer. Machine & Metals, Inc.

Centrifuges, Hermetic.....Long-life seals at inlet & outlets maintain postive pressure. Booklets S. A969 &S. A983 give specifications & operating details.
84 *De Laval Separator Co.

Dryers, Spray.....A new full-color bulletin SW 401 "Swenson Parallel Flow Spray Dryers" gives information on evaporators, pulp washers & crystallizers.
23 *Swenson Evaporator Co.

Drying Systems, Flash.....for production of fine dry powered materials by automatic dust-free operation. Details for requirements.
110 *Combustion Engineering, Inc.

Dust Collectors.....Duclones are available in a wide range of capacities & in multiple units & special materials for every application. Bulletin C-958
81 *The Ducon Company, Inc.

Dust Collection Systems.....Booklet, "The Collection & Recovery of Industrial Dusts," gives information on Cyclone, "SF" Electric Precipitator & Precipitator-Cyclone.
180 *Buell Engineering Co.

Filters.....No separate scavenging operation with this filter . . . downtime reduced & no liquid heel left at end of filtration cycle. Information available.
162 *Amer. Mach & Metals, Inc.

Filters.....Illustrated Bulletin GEO-506 gives applications on all Fulflo model filters. Exclusive honeycomb tubes give true depth filtration.
177B Commercial Filters Corp.

Filters.....Designed for all vacuum filter applications. Bulletin #KSI-2-3 detailed information and illustrations plus specifications of Pilot Plant Equipment.
Komline-Sanderson Engineering Corp.
177C

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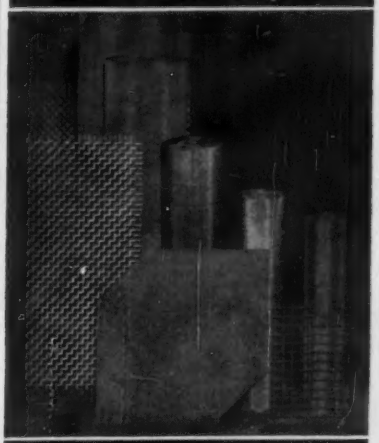

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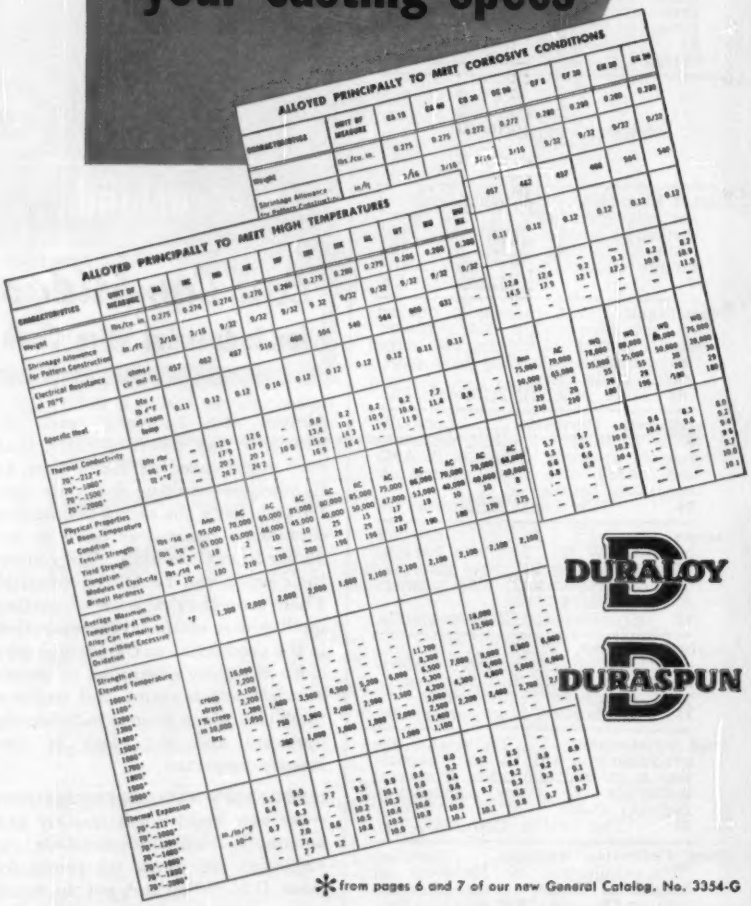
TABLES to help you select the proper alloy for your casting specs



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— and there's lots more useful information about high alloy castings in our up-to-date catalog describing Duraloy Service. SEND FOR YOUR COPY.

As one of the pioneers in both static (1922) and centrifugal (1931) high alloy castings, we have a wealth of experience to focus on your high alloy casting problem. Send for our catalog, study it, and then let us help you get the best alloying combination to solve your corrosion, high temperature and/or abrasion problem.

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LITERATURE . . .

Filters.....five bulletins offered on vertical leaf & batch, horizontal leaf & batch, & cartridge filters. Wide range of accessories. Specify bulletin from ad.
69 *Process Filters, Inc.

Filters.....Catalog, up-to-date fully illustrated reference manual of erection, operating, design & construction data & specifications is available.
187 *D. R. Sperry & Co.

Filter Fabrics.....all types of wet or dry filtration equipment. Technical assistance in selecting proper fiber & fabric construction for requirements. Bul. KSF-1
178A Komline Sanderson Corp.

Filters, Oil.....Features quick-opening covers, easy-to-change cartridges, choice of 6 filter media & electric, steam or hot water heat. Details in Bul. 201.
178B Commercial Filters Corp.

Mills, Hammer.....crushes, grinds, shreds to finished size in one operation. Offers more uniform product, increased output. Catalog available.
63 *Williams Patent Crusher & Co.

Mixers.....the Turbulizer is a high speed, continuous mixer designed to provide disintegration & blending of dry materials, or pastes involving liquids. Color Bulletin.
77 *Strong-Scott Mfg. Co.

Pressure Vessel.....constructed from zircaloy-2 for the first two-region breeding homogeneous reactor. Illustrated booklet "Facilities & Products", available.
28 Newport News Co.

Processing Equipment.....Catalog No. 258 for detailed information on custom fabrication & erection of processing vessels & equipment for industry.
79 *Nooter Corp.

Process Equipment.....Drum dryers convert liquids to dry solids, Flakers convert molten products to solid flakes, & Vacuum rotary dryers for heat sensitive products.
164 *Goslin-Birmingham Mfg. Co.

Processor.....For chemicals, pharmaceuticals or other temperature-sensitive products, Turba-Film retains essential properties & desired qualities of product produced.
65 Rodney Hunt Machine Co.

Pulp Press.....The intermediate press for the continuous separation of liquids from solids. Bulletin ZM-149 gives details on engineering features.
178C Jackson & Church Co.

Reactor Shell.....of carbon steel, built to specifications. Brochure "Working With Metal" gives factual information on designing, engineering & specialized fabrication.
186 *The Boardman Co.

Regulators, Atmospheric.....deliver gas to burners at zero pressure & maintain gas-air ratios over a wide range of turn down. Bulletin 6000 gives details.
178D Norwalk Valve Co.

Roto-Pulper.....The 015 model is a vertical single disc refiner featuring a rotating disc mounted on a vertical shaft. Applications listed in bulletin.
178E Jackson & Church Co.

* From advertisement, this issue

How to

CONDENSE STEAM

and

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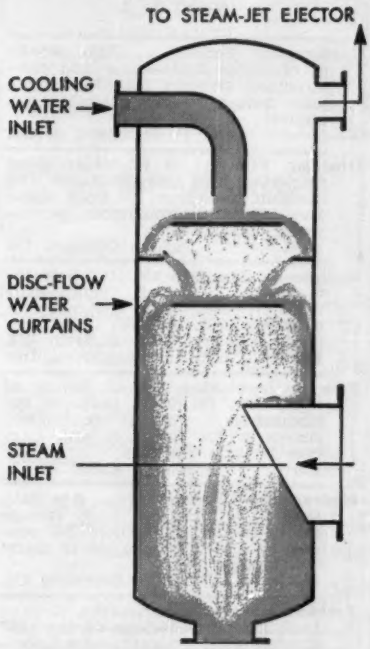
LOW COST



I-R Disc-Flow Barometric Condensers provide a simple and low-cost method for condensing steam and creating a vacuum wherever condensate is expendable. Their high efficiency, simplicity of operation and overall economy make them ideal for use with steam engines, turbines, vacuum pans and a wide range of high-vacuum processes.

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Send for Bulletin No. 9012-A

Ingersoll-Rand

4-778 ♥ 11 Broadway, New York 4, N. Y.

LITERATURE . . .

Pumps, Blowers, Compressors

Air-Conditioning System.....Kathabar systems maintain spaces at 80F & 55%RH, or lower, for processing, storage & testing. For use in various industries.
36 *Surface Combustion Corp.

Air Handling.....The three new methods of bulk handling; Cyclo-Vac, Flow Diverter, and Fluidizer offer economical, sanitary and efficient service.
BL153 *Superior Separator Co.

Air Separators.....circulate production loads of up to 800 tph. Nine models available with diameters from 3 to 18 ft. Information contained in Bul. 087.
L177 *Sturtevant Mill Co.

Compressor, Barrel-Type.....Boosts high pressure levels in range of 50 to 500 psia. Extends range of single-stage units into levels handled by reciprocating types.
103 *Allis-Chalmers.

Compressors.....Type Y offer 75 to 250 horsepower & vacuum service & pressures to 5,000 lbs. The built-in motor provides oil-free air for process work.
16-17 *Chicago Pneumatic Tool Co.

Compressors.....are compact & space-saving, have no internal wearing parts, no internal lubrication & handle 75 lbs. in a single stage. Bulletins available.
30 *Nash Engineering Co.

Fans.....Bulletin F-200 gives details on model BLH for High Pressures. Information on moderate pressure applications on type BL is discussed in Bul. F-104.
86 *Buffalo Forge Company

Pumps.....decreased down-time to a minimum . . . maintenance costs reduced substantially. Full information available as to installation & maintenance.
42 Aldrich Pump Co.

Pumps.....Full dimensional, construction & performance data for your particular problems in Bul. 5000. Includes; Olivite (Lined), Alloy (Type L) & Diaphragm (O. D. S.).
54-55 Dorr-Oliver Inc.

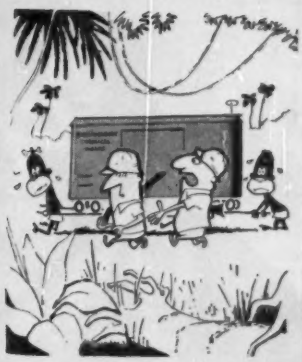
Pumps.....The H Durcopumps are built with capacities from ½ to 3500 gpm, & with heads to 345'. Available in 12 standard corrosion resisting alloys.
145 *The Duriron Co.

Pumps.....custom built enclosed impeller & open impeller types. Pump sizes from 1" to 4" discharge openings, capacities from 50 up to 700 U. S. GPM. Bulletin 107.
L169 *Frederick Iron & Steel, Inc.

Pumps.....ideally suited for handling all corrosive materials. Bulletin 725.2 gives complete details on a new centrifugal pump. & materials it handles.
18 Goulds Pumps, Inc.

Pumps.....Type G pumps handle considerable quantities of acetic anhydride & phosphoric acid. This type is packingless, never needs servicing to prevent leaks.
49 *La Bour Company, Inc.

* From advertisement, this issue



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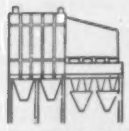

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Pumps, Acid.....Available with pumping parts of the machinable alloys as well as plastic to meet all requirements. Request complete details.
31 *A. R. Wilfley & Sons, Inc.

Pumps, Vertical.....with no submerged bearings for pumping abrasive corrosive slurries. Bul. 203-7 for complete summary of acid & chemical pump data.
157 *Lawrence Pumps, Inc.

Services, Processes, Misc.

Construction Service.....Full details of complete engineering and construction services for the chemical industry are available on request.
1 *J. F. Pritchard & Co.

Drafting Film.....4 p. folder gives properties of a tear-proof drafting medium made from Du Pont Mylar base. Discusses toughness, permanence, transparency.
180A Eugene Dietzgen Co.

Equipment, Bench-Scale.....New integrated line of bench-scale research equipment designed for a variety of exploratory lab studies is described in 8 p. Bulletin 658.
180B Autoclave Engineers, Inc.

Fire Extinguishing.....All kinds of equipment including portable extinguishers, mobile equipment, smoke & fire detectors and Carbon Dioxide Systems.
168 *Walter Kidde & Co.

Instruments, Laboratory.....6 p. data sheet 4/58 describes high voltage electrophoresis equipment for separation and identification of many compounds.
180C Shandon Scientific Co.

Precautionary Labeling.....A 52 page book gives proceedings on the 1957 Conference on Precautionary Labeling. Includes papers presented & attendance list. No. 1386.
101-102K U. S. I. Chemicals Co.

Respirator.....assured protection against insecticides . . . and best paint spray respirator, too. With one basic face piece, 14 respirators are possible. Literature.
9 *American Optical Co.

Scale Removers.....8 p. folder RECWT describes a complete line of water treatment products for evaporative condensers, cooling tower systems.
180D Calgon Co.

Sterilization System.....Illustrated brochure gives data on the availablity, proper layout & installation of every type of sterilizing device manufactured.
180E Wilmot Castle Co.

Waste disposal systems.....the new Dumpmaster self-loading packer cuts waste disposal costs by two-thirds in chemical processing plants. Free 40-page bulletin.
20 *Dempster Bros.

* From advertisement, this issue

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Kettles: St. steel, with and without ag. Dopp 150 gal. dbl. act. agitator.
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4 Unused Pfaudler Glass Lined REACTORS Model R78; 2000 Gal. Jkt. 75 Lbs. Int. 50 PSI

3 A. O. Smith Stainless Lined Pressure Tanks; 10' x 18'7"; 11,000 gal. like new condition

Blaw Knox Stainless Reactor or Resin Kettle 7' 6" x 7'6"; welded; Jacketed; Agitated

4 Stainless Steel 5000 Gal. Closed Top Tanks, Welded construction; 10' diameter; agitated

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NEW Falcon Stainless Reactor; 125 Gal. 30" x 30"; Jacketed; Agitated; Motorized

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Tolhurst 40" Center Slung, Rubber Covered Basket & Curb; Monel Plow; 2 Speed Motor

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Patterson Jacketed Ball Mills; 54" x 42" Model DJ

Sifters and Screens by Day RoBall; Orville Simpson Rotex, Gyro Whip; Patterson, Robinson; all sizes, types

4 Stainless Mikro Pulverizers Model No. 2; other Mikros from Bantam size up to No. 4

Fitzpatrick Stainless Comminutators; Models D and K

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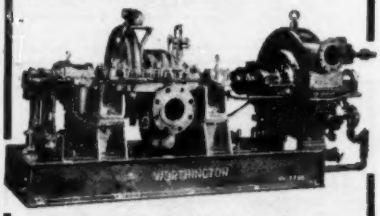

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September 8 Issue
August 11 Issue

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604—24 Stainless Roto-Louvre Dryer
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1,000,000 B T U flash hour gas fired furnace with accessories.
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1—Dracco Type S, 3 Compartment Dust Collector.
Bristol Recording thermometers & controllers, etc.

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27—Hangers
} For a 6' x 50' Louisville Steam Tube Dryer

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1—Louisville Steam Tube Dryer 6' x 50', converted to a cooler
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2—Oliver Drum filters—8' x 12'
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Filter covers and bags to fit above.

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10—Lead lined, agitated Tanks, 1000 to 6500 gallons.
Troughing Belt Conveyors; Bucket Elevators; Bins, 50 to 500 tons; Ball Mills; Jaw Crushers; Roll Crushers; Air Compressors.

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2—Pfaudler 1500 gal. glass lined, jacketed, agitated Reactors, 90# jacket.
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2—Patterson 1000 gal., steel, jacketed, agitated Reactors, 20 HP.
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Aerofin Corp. 160
Aldrich Pump Co. 42
Allegheny Ludlum Steel Co. 52
Allis-Chalmers Mfg. Co. General Machinery Div. 103
Allis Co., Louis 139
Aluminum Co. of America Chemical Div. 39
American Cyanamid Co. 12-13
American Hard Rubber Co. 150-151
American Optical Co. 9
Amercoat Corp. 87
Armco Steel Corp. 47
Atlas Mineral Products Co. 175
Autoclave Engineers 88

Bailey Meter Company 44
Baker & Adamsen Div. Allied Chemical Corp. 57
Becco Chemical Div. Food Machinery & Chemical Corp. 29
Bird Machine Company 4
Black, Sivalls & Bryson Controls Div. 96
Safety Head Div. 158
Blaw-Knox Co. Buflovak Div. 45
Boardman Company 186
Bowser, Inc. 94
Brookfield Engineering 149
Buell Engineering Co. 180
Buffalo Forge Company 86

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ADVERTISERS

Cambridge Wire Cloth Co..... 177
Celanese Corp. of America..... 71
Chemical & Industrial Corp..... 48
Chicago Pneumatic Tool Co....16-17
Cleaver-Brooks Co..... 156
Combustion Engineering, Inc.
Raymond Div. 110
Coppus Engineering Co..... 43
Crane Company 109

Dean Products. Inc.
Dean Thermo-Panel Coil Div. 148
DeLaval Separator Co..... 84
Dempster Brothers 20
Dorr-Oliver, Inc. 54-55
Ducon Company 81
Duraloy Company 178
Duriron Company, Inc., The.... 145

A. H. Emery Co..... 25
Esso Standard Oil Co..... 73
Ever-Tite Coupling Co..... 148

Fansteel Metallurgical Corp..... 159
Flexonics Corp. 170
Flowline Corp. 6
Foster Wheeler Corp..... 61
Frederick Iron & Steel, Inc..... 169

General Electric Co.....10-11
Goslin-Birmingham Mfg. Co., Inc. 164
Goulds Pumps, Inc..... 18
Great Lakes Carbon Co.
Nerofil Dept. 90

Hapman Conveyors, Inc..... 149
Haynes Stellite Co., Div. of Union Carbide Corp..... 143
Hough Co., Frank G..... 8
Hunt Machine Co., Rodney..... 65

Ingersoll-Rand Co. 179

Jamesbury Corp. 152
Jenkins Bros. 85

Kennedy Van Saun Mfg. & Engrg. Co. 169
Kidde & Company, Walter..... 168
Koppers Company 67

LaBour Co., Inc., The..... 49
Lawrence Pumps, Inc..... 157
Leeds & Northrup Co..... 32
Linde Company
Div. of Union Carbide Corp... 19
Link-Belt Co. 7
Ludlow-Saylor Wire Cloth Co... 174
Luzerne Rubber Co..... 175

Mallinckrodt Chemical Works 153, 179
Mallory-Sharon Metals Corp.... 95
Manning, Maxwell & Moore, Inc. 24
Master Electric Co.....Third Cover
Mine Safety Appliances Co..... 83
Monarch Mfg. Works, Inc..... 159
Mueller Brass Co..... 153

Nash Engineering Co..... 30
National Carbon Co.
Div. of Union Carbide Corp... 46
Neptune Meter Co..... 166
Newport News Shipbuilding & Dry Dock Co..... 28
Niagara Blower Co..... 149
Niagara Filter Div.
American Machine & Metals, Inc. 162
Nicholson & Co., W. H..... 82
Nooter Co. 79

Oakite Products, Inc..... 188

Pennsylvania Flexible Metallic Tubing 167
Pfaudler Co., Div. of Pfaudler-Permutit, Inc.....Fourth Cover
Pitt-Consul Chemical Co..... 161
Powell Valves, Wm. Powell Co... 141

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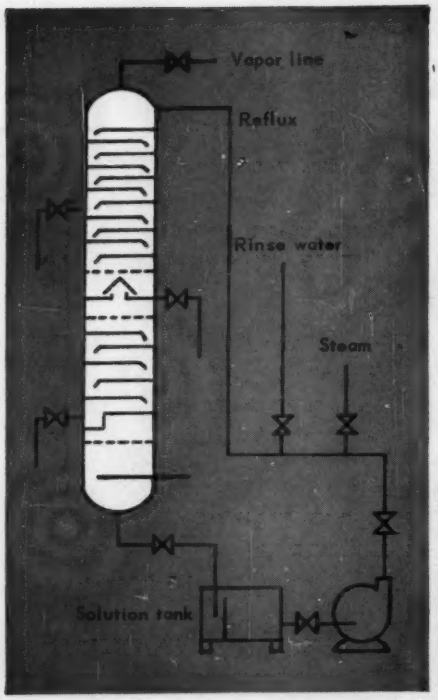

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ADVERTISERS . . .

Pritchard J. F. & Co..... 1
Process Filters, Inc..... 69

R & I E Equipment Division I-T-E Circuit Breaker Co..... 26
Resistoflex Corp. 137
Reynolds Metals Co..... 41
Rockwell Mfg. Co. Nordstrom Valve Div.....33-34
Roots-Connersville Blower, Div. of Dresser Industries.....154
Ross Heat Exchanger Div. American Standard 35
Ryerson & Sons, Inc., Joseph T. 112

Schutte & Koerting Co..... 37
Shell Oil Company..... 59
Solar Aircraft Co..... 22
Solvay-Process Div. Allied Chemical Corp..... 75
Sperry & Co., D. R..... 187
Sturtevant Mill Co..... 177
Strong-Scott Mfg. Co..... 77
Superior Separator Co..... 153
Surface Combustion Corp..... 36
Swenson Evaporator Co., Div. of Whiting Corp. 23

Terry Steam Turbine Co..... 108
Texas Gulf Sulphur Co..... 27
Timken Roller Bearing Co..... 21
Thermo Electric Co..... 165
Tolhurst Centrifugals, Div. of American Machine & Metals, Inc. 163
Tractomotive Corp. 93
Traylor Engineering & Mfg. Co. 38
Tube Turns, Div. of Chemetron Corp. ..Second Cover

United Electric Controls Co..... 176
Union Carbide Olefins Co. Div. of Union Carbide & Carbon Co. 167
U. S. Electrical Motors..... 89
U. S. Gasket Co., Plastics Div. of Garlock Packing Co..... 155
U. S. Industrial Chemicals Co Div. of National Distillers & Chemical Corp. 101-102
U. S. Rubber Co..... 147
U. S. Stoneware Co., The..... 50

Vogt Machine Co., Henry..... 135

Wagner Electric Corp..... 40
Westinghouse Electric Co.....14-15
Wilfley & Sons, A. R..... 31
Williams Patent Crusher & Pulverizer Co. 63
Wolverine Tube Co., Div. of Calumet & Hecla, Inc..91-92

Professional Services 181

CLASSIFIED ADVERTISING
F. J. Eberle, Business Mgr.

EQUIPMENT

(Used or Surplus New) For Sale 181-185

ADVERTISERS INDEX

Aaron Equipment Co., Div. of Araco, Inc..... 184
American Air Compressor Corp... 183
Brill Equipment Co..... 183
Equipment Clearing House Inc... 183
First Machinery Corp..... 182
Foster Co., L. B..... 183
Gelb & Sons, Inc. R..... 185
Heat & Power Co., Inc..... 182
Hershey Estates-Extraction Div.. 183
Lawler Company 181
Loeb Equipment Supply Co..... 181
Machinery & Equipment Corp., N. J. 183
Machinery & Equipment Co., Calif. 181-182-184
Maritime Power Corp..... 182
Perry Equipment Corp.....182-184
Stein Equipment Company..... 183
Sussman Inc., Louis..... 183
Union Standard Equipment Co... 184

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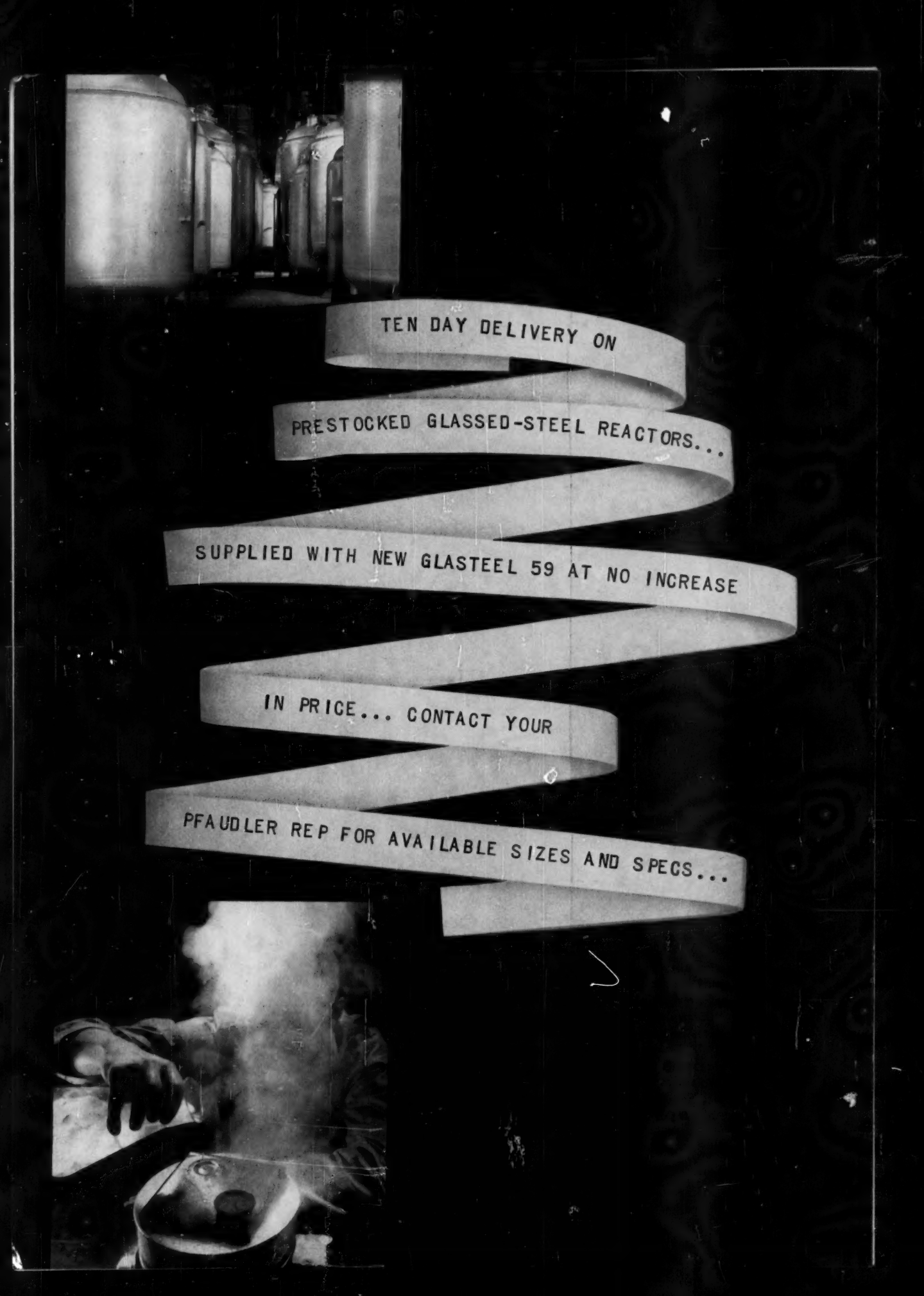
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